Forest Insect and Disease Conditions in Canada 1989

Le Relevé des insectes et des maladies des arbres (RIMA) est un programme national regroupant six unités régionales et comportant un programme de développement technologique. Ses activités sont gérées par les établissements régionaux de Forêts Canada. Le RIMA permet de renseigner les aménagistes, les responsables des pavillons de quarantaine, les chercheurs, les enseignants et le public sur les conditions des insectes et des maladies, y compris les effets des pluies acides.

The Forest Insect and Disease Survey (FIDS) is a nationally coordinated program of six regional FIDS units and the FIDS Technology Development Project. Its activities are managed by the regional Forestry Canada establishments. The program provides perspectives on insects and disease, including effects of acid rain, to forest managers, quarantine agencies, researchers, educators, and the public.

Cover: Jack pine trees infected by dwarf mistletoe (Northern Alberta).

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Forest Insect and Disease Conditions in Canada 1989

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Introduction

The Forest Insect and Disease Survey (FIDS) is a nationally coordinated program of six regional FIDS units and the FIDS Technology Development Project. Its activities are managed by the regional Forestry Canada establishments. The program provides perspectives on insects and disease, including effects of acid rain, to forest managers, quarantine agencies, researchers, educators, and the public.

Significant changes are now being made to FIDS through its new Strategic Plan. The FIDS Strategic Plan defines the role of FIDS and its responsibilities in relation to other federal and provincial agencies. It also provides guidance for FIDS program development and activities over the next several years. The levels of provincial and industry involvement and their roles in Forest Insect and Disease Surveys are becoming increasingly diverse. However, there is a need to maintain the capacity to carry out federal mandates.

The proposed strategic direction for FIDS includes:

1) Intelligence gathering: analysis and generation of knowledge, forecasting and prediction;
2) Identification of federal/provincial survey responsibility;
3) Special surveys and studies: Research, development, and implementation of survey techniques and methodologies;
4) Identification and establishment of the FIDS role in the Plant Quarantine Act and in interprovincial and international marketing relationships.

"Forest Insect and Disease Conditions in Canada 1989" is the ninth in a revised format of a series of national annual reports of the Forest Insect and Disease Survey that date back to at least 1936. In cooperation with those responsible for improving forest inventory and economic data in Canada, the survey attempts to provide more quantitative and interpretive data on damage and depletion caused by forest pests. The initiative requires the development of methodologies and procedures before complete and accurate data can be made available. As forest management intensifies and old growth forests are gradually replaced by new, managed forests, novel pest problems and impacts will arise and require increased attention (for example, the spruce budmoth). Accordingly, regional and national reporting will continue to be modified to reflect the changing activities and findings of the Survey.

This report is produced through a cooperative effort of the six Forestry Canada regional establishments. The Forest Pest Management Project (formerly FIDS Technology Development Project) coordinates technology development for FIDS. Based at the Petawawa National Forestry Institute (PNFI), the project draws on the strength of resident expertise in computing, data analysis, remote sensing, and modelling in support of FIDS activities.

The present work describes in detail, under the title "Major Forest Insects and Diseases", pests considered to be currently significant in terms of their present or potential economic, sociological, or environmental impact. Regional surveys of pest problems in special situations or of specific pests are summarized under "Special Surveys". The status of many other pests is presented in tabular form by region under the heading "Other Insects, Diseases, and Damage". Although they do not, in most cases, have spectacular effects, they are important because of their potential for expansion, quarantine considerations, their possible role as vectors, and as indicators of other problems. Additional information on these and other pests can be obtained from regional forestry centres of Forestry Canada.

There are several insidious forest pests in Canada that are not amenable to routine detection surveys and which, therefore, escape annual census; nevertheless, they do cause significant losses. This report recognizes the importance of these pests through periodic descriptive, if not quantitative, reviews.

As much as possible in this report we have used current nomenclature and authorship to designate pest species. Because the taxonomy of some species changes occasionally and old names tend to persist, we have striven to realistically balance clear communication to our audience with the incorporation of taxonomic revision.

In addition to those already named we would like to acknowledge the field and laboratory staffs of the forest centres, officers of provincial and federal governments and agencies, the forest industry, and private individuals. The ministère de l'Énergie et des Ressources du Québec, Service de la protection contre les insectes et les maladies (SPIM) provided most of the information from Québec, except the pinewood nematode survey and balsam fir special survey, which was done through the FIDS unit at Forestry Canada, Québec Region. Finally, we thank those who provided us with comments and suggestions on previous reports.

B.H. Moody
Coordinator, Forest Insect and Disease Survey

Summary of Defoliation and Damage Estimates

A summary of areas affected in 1989 by major defoliating insects or bark beetles is presented in Table 1 to illustrate the magnitude of the problem. This is done in full realization that strict comparison is not possible; usually a succession of defoliation years is required to kill a tree, and this varies with the pest, the tree species being attacked, and other factors, some of which may be poorly understood. As well, growth losses incurred as a result of pests and the factors influencing these losses are even less well known. Differences in survey methodologies and intensities for each pest further complicate comparisons.

Table 1. Selected Major Pests: Comparative estimates of areas of moderate to severe defoliation and beetle-killed trees in 1989 ('000 ha)

Province or territory	Spruce budworm	Jack pine budworm	Mountain pine beetle[a]	Hemlock looper	Forest tent caterpillar	Gypsy moth
Newfoundland	1	-		9	-	
Prince Edward Island	0	-		-	-	
Nova Scotia	0	-		-	-	
New Brunswick	396	-		2	-	
Québec	700	-		-	372	6
Ontario	6240	248			7915	82
Manitoba	58	0			325	
Saskatchewan	35	0			791	
Alberta	86	0			1190	
Northwest Territories	99	-			-	
British Columbia[b]	124[c]	-	53		122	
Total	7739	248	53	11	10 715	88

[a]Areas where beetle-killed trees occurred. Estimated volume killed in 1989 is 1.07 million m^3.

[b]Western spruce budworm caused light to moderate defoliation on an additional 165 800 ha.

[c]Light to moderate defoliation.

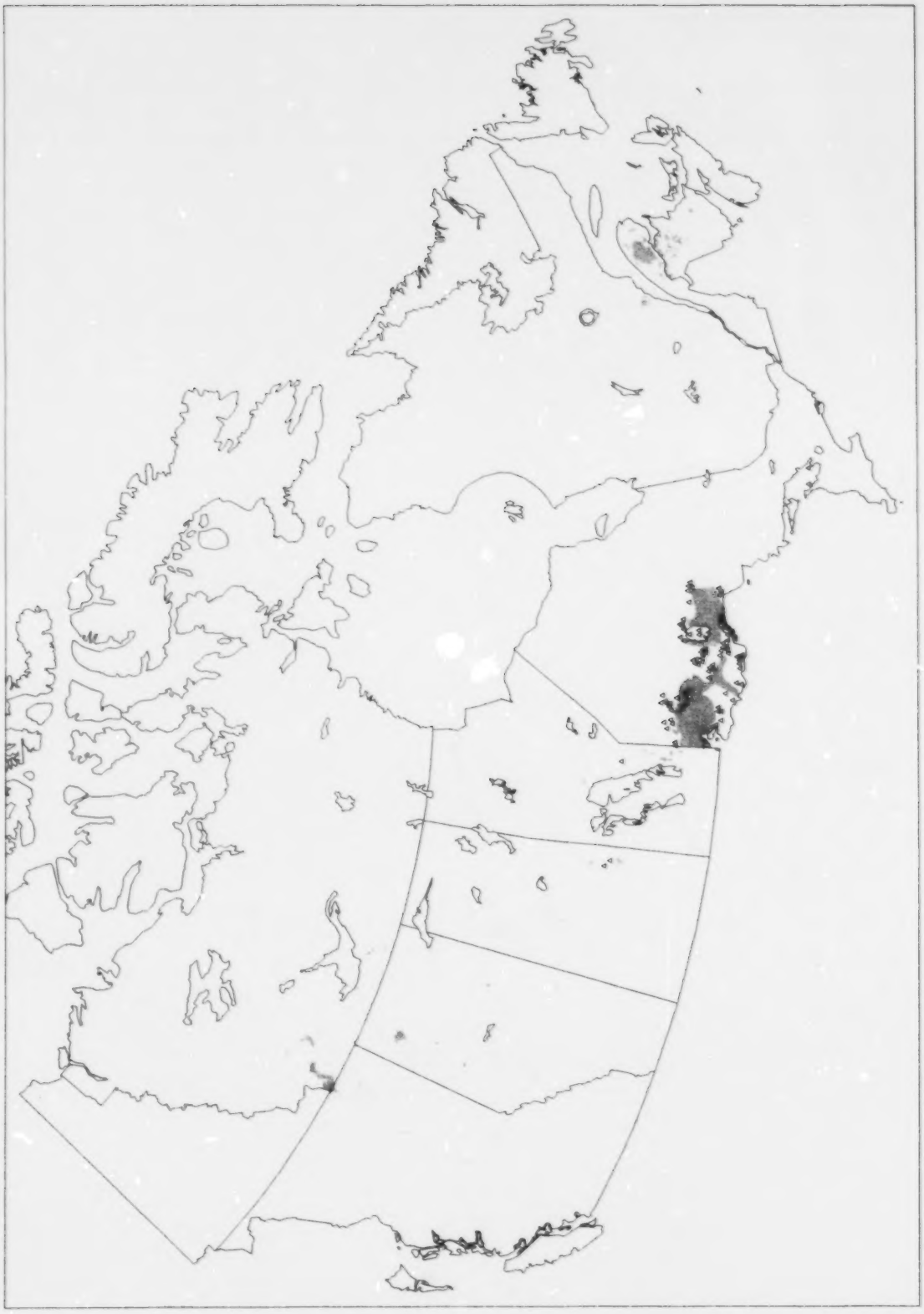

Figure 1. Areas of moderate to severe defoliation by the spruce budworm, 1989.

Major Forest Insects and Diseases

Spruce budworm
Choristoneura fumiferana (Clem.)

The spruce budworm continues to be Canada's most destructive forest pest. Balsam fir is the preferred host of the spruce budworm, but it feeds heavily on red spruce, white spruce and, to a lesser extent, on black spruce. At very high population levels, this budworm will also attack hemlock and larch. In 1989, populations increased from 1988 levels in Canada and the area within which moderate to severe defoliation occurred increased to 7.7 million ha (Figure 1) from 6.3 million ha. Spruce budworm populations and the area of defoliation have shown a marked increase in 1989 compared to the overall downward trend in eastern North America during the last few years.

In Newfoundland, the budworm population decreased slightly and the insect caused moderate to severe defoliation over 396 000 ha in New Brunswick in 1989. There was no defoliation detected during aerial surveys in Nova Scotia and Prince Edward Island. In Québec the infestation increased significantly, with a 31% overall increase since 1988. In Ontario, the area over which moderate to severe defoliation occurred increased in 1989, reversing the declining trend of the past several years.

Spruce budworm infestations increased significantly in size and intensity in Alberta, Manitoba, and the Northwest Territories but only slightly so in Saskatchewan. In British Columbia, the infestations in alpine fir and white spruce increased more than threefold compared to 1988.

Aerial spray operations were conducted in Alberta, Manitoba, Ontario, Québec, and New Brunswick covering a total of 0.8 million ha. Table 2 shows the areas of moderate to severe defoliation by province and the areas sprayed to control spruce budworm in 1989. Table 3 shows areas defoliated and sprayed since 1980.

Table 2. Area of moderate to severe defoliation by province and area sprayed to control spruce budworm in 1989

Province	Area of moderate to severe defoliation ('000 ha)	Area sprayed ('000 ha)
Newfoundland	1.0	0
Prince Edward Island	0	0
Nova Scotia	0	0
New Brunswick	396.0	611.2
Québec	700.0	165.0
Ontario	6240.0	30.5
Manitoba	58.0	5.4
Saskatchewan	34.6	0
Alberta	85.8	1.0
Northwest Territories	98.6	0
British Columbia	124.0	0
Total	7738.0	813.1

Table 3. Area of moderate to severe defoliation and area sprayed to control spruce budworm since 1980 in Canada

Year	Area of moderate to severe defoliation ('000 000 ha)	Area sprayed ('000 000 ha)
1980	36.2	1.9
1981	37.0	2.9
1982	18.2	3.0
1983	23.8	3.1
1984	16.8	2.0
1985	20.2	1.5
1986	12.3	0.8
1987	8.4	0.9
1988	6.3	0.7
1989	7.7	0.8

Newfoundland

Defoliation - Two new infestations of the spruce budworm were recorded in 1989, one near the North Branch of the Codroy River in western Newfoundland and the other along La Poile River on the South Coast. Three small older infestations, two in the Codroy Valley and one on the Baie Verte Peninsula, decreased in size and all had reduced population levels in 1989. These three infestations have continued since the collapse of the last budworm outbreak. Outside of the infestation areas larval populations were low. Moderate and severe defoliation was recorded on 1000 ha and light defoliation on 66 ha.

Damage - No appreciable damage.

Control - No operational or experimental control program was conducted in 1989.

In 1989 larvae were intensively sampled in the area of infestations and extensively throughout the Island. In the declining infestation on the Baie Verte Peninsula 30% of the 323 larvae sampled were parasitized by *Glypta fumiferana*, 18% were dead and contained *Aureobasidium pullulans*, 4% were killed by the fungus *Entomophaga aulicae*, about 1% were infected with *Nosema fumiferana*, and about 7% died containing unidentified organisms for a total late-larval mortality of 60%. Larval mortality of samples from other areas throughout the Island was only 1.4% of 71 larvae collected.

Monitoring - Pheromone traps were placed at 50 permanent sample locations throughout the Island. The total number of moths trapped increased from 186 in 1988 to 3130 in 1989. The highest numbers recorded were along the west coast, but not near areas of infestation.

Many moths were found in traps before local moths had emerged, suggesting that almost all moths trapped had been transported into Newfoundland by warm air masses from mainland Atlantic Canada. Overwintering larval populations were sampled in 430 locations in conjunction with the hemlock looper egg sampling in October.

Nova Scotia

Defoliation - For the third consecutive year, there was no defoliation of balsam fir or spruce detectable during the annual spruce budworm aerial survey in Nova Scotia in 1989. Only trace defoliation was detected during ground surveys on small groups of trees in previously damaged areas of the province.

Damage - No specific budworm damage surveys conducted.

Control - No control measures on an operational scale were carried out.

Monitoring - The overwintering larval (L_2) survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel. Information from 240 sample locations indicated that while L_2 populations were negligible or low at 95% of the locations sampled some populations increased.

Prince Edward Island

Defoliation - Noticeable defoliation occurred in 1989 mostly of white spruce, following two years when no defoliation was observed on balsam fir or spruce during aerial surveys. The total area of severe and moderate defoliation was approximately 100 ha, observed during combined aerial and ground surveys, and occurred in isolated patches in Queens and southeastern Kings counties. White spruce defoliation was severe in parts of Prince Edward Island National Park and at Orwell in Queens County and moderate at Breadalbane, Uigg, and near Eldon, Queens County, near Pooles Corner, Georgetown, St. Peters Road and Brooklyn, Kings County. Light defoliation was also noted at several scattered locations in the two eastern counties. Balsam fir was virtually unaffected in 1989.

Damage - No specific spruce budworm damage surveys conducted by FIDS.

Control - Control measures on an operational scale were not carried out.

Monitoring - The survey of overwintering larvae (L_2) was conducted by Forestry Canada - Maritimes Region at 41 locations. Populations were moderate at 5%, low at 75%, and nil at 20% of the locations sampled. These population levels were lower than those obtained in 1988. However, over 12 200 spruce budworm moths were captured in the light trap at Kilmuir, Kings County, the highest catch in the Maritimes in 1989.

New Brunswick

Defoliation - Defoliation of balsam fir and spruce stands was recorded in 463 000 ha in the Province in 1989 (Figure 1). Defoliation was severe on 267 000 ha, moderate on 129 000 ha, and light on 67 000 ha. The 396 000 ha of severe to moderate defoliation was only 20% less than the 500 000 ha recorded in these categories for 1988. Most defoliation occurred in the northern half of the Province.

Damage - No specific spruce budworm damage surveys conducted by FIDS.

Control - Foliage protection was conducted over 611 200 ha in 1989; 576 900 ha by Forest Protection Ltd. and 34 300 ha by Forest Patrol Ltd.

Forest Protection Ltd. treated 576 900 ha of forest in 1989. Of this, approximately 472 000 ha were treated with fenitrothion (Sumithion®) and 105 000 ha with the biological insecticide *B.t.* (Futura XLV®). The rates of application were 210 g/ha for fenitrothion and either 15 BIU/ha or 30 BIU/ha for *B.t.* About 62% of the treated area received two applications.

Forest Patrol Ltd. treated 34 300 ha of forest in 1989. Of this, approximately 31 600 ha received two applications of fenitrothion (Sumithion®) at the rate of 210 g/ha/application, 2100 ha received a single application of *B.t.* at the rate of 30 BIU/ha, and the remainder (2%) received a single application of fenitrothion followed by an application of "Matacil rinse", at the rate of 3.5 L/ha.

Monitoring - Overwintering larval (L_2) surveys were conducted by the New Brunswick Department of Natural Resources.

Québec

Defoliation - In 1989, spruce budworm populations increased substantially in the Lower St. Lawrence - Gaspé region. Damage caused by the insect was particularly severe in the central part of the Gaspé peninsula. Populations remained stable in the North Shore region and spread to areas surrounding those affected in 1988. The insect continued to decline on Anticosti Island and in the Trois-Rivières region. However, populations remained at an endemic level in the other regions of Québec.

The spruce budworm infestation covered an area of 0.92 million hectares in 1989, compared with 0.70 million hectares in 1988. Damage was light over 0.19 million ha, moderate over 0.22 million ha, and severe over 0.51 million ha. Damage was moderate to severe over 79% of the area affected by the spruce budworm in the province. The area affected in 1989 was 31% larger than that affected in 1988. There was a 37% increase in the Lower St. Lawrence - Gaspé region and 42% in the North Shore, excluding Anticosti Island. Areas of defoliation in the Lower St. Lawrence - Gaspé account for 88% of the total area affected by the spruce budworm in the province. Damage was more severe over 59% of the area affected in this region.

Damage - There were no specific spruce budworm damage surveys in 1989.

Control - The Québec Department of Energy and Resources conducted its twentieth aerial spray program to control spruce budworm. A total of 165 034 hectares of forest in Lower St. Lawrence - Gaspé region were treated, a slight decrease compared with the 197 992 ha and 192 073 ha treated in 1987 and 1988, respectively. The areas in which spruce budworm populations were very high in 1989 (38 379 ha) were treated with a second application of insecticide.

The biological insecticide Dipel 132® (*Bacillus thuringiensis* var. Kurstaki) was sprayed undiluted over an area of 125 170 ha at a rate of 30 BIU/ha in a volume of 2.37 L/ha. The other part of the area (24%) was sprayed with Dipel 76®, which was also applied undiluted at the same rate in a volume of 1.77 L/ha. Spraying operations were carried out from June 2 to July 1 using two DC-4s, one DC-6, three Bull Thrushes, and two AgCats.

In 1989, the results of the spraying program were slightly inferior to those achieved in previous years. Defoliation that would have been caused by the spruce budworm was reduced by 20 to 30%, but the program was not sufficient to prevent severe defoliation of annual shoots over a large part of the area. The aerial survey of annual damage revealed severe defoliation over 35% of the area treated, a significant increase over previous years (15%). The foliage protection afforded by the treatments was reduced owing to the density of larval populations. The most severely infested areas could not be adequately protected, despite a second application of insecticide. However, two applications were much more effective than a single application in the severely affected areas. The disappointing results were due to the lateness of the *B.t.* spraying, attributable to the poor weather which delayed the operations, and to high larval populations. Nonetheless, the *B.t.* treatment had a marked impact on the population levels of the next generation in the areas treated in 1989. Despite the dispersal of moths, the 1990 population levels in the areas treated in 1989 will clearly be lower than in the untreated areas.

Monitoring - The number of male moths captured this year increased in several regions over 1988, and this increase was significant in the western part of the province.

Sampling of hibernating populations was conducted at 1200 sample plots located primarily in the Lower St. Lawrence - Gaspé and North Shore regions. Hibernating populations were also studied at roughly 20 sites in western Québec (mainly the Outaouais region) where large populations of moths were caught using pheromone traps. A few areas in the Trois-Rivières region, too, had high populations.

Ontario

Defoliation - The total area of moderate to severe defoliation in Ontario increased by over a million ha, to 6 239 636 ha, reversing the declining trend of the past several years. Moderate to severe defoliation remains confined to the Northwestern Region and Northcentral Region. In the Northwestern Region declines in the Ignace, Dryden, Red Lake, and Fort Frances districts were offset by increases in the Sioux Lookout and Kenora districts. Similarly, in the North Central Region, a small decrease in the Atikokan District was contrasted by major increases in Thunder Bay, Nipigon, Terrace Bay, and Geraldton districts. The outbreak is characterized by two large areas of moderate to severe defoliation surrounded by many smaller ones. The largest, some 3.7 million ha in size, stretches from the Manitoba border east through parts of Kenora, Fort Frances, Red Lake, Sioux Lookout, Dryden, Ignace, and Atikokan districts to the western Thunder Bay District. The second largest occupies 2.1 million ha from the eastern Thunder Bay District through the Nipigon District to the western Geraldton and Terrace Bay districts. Much of the infested area in the Geraldton and Terrace Bay districts was free of infestation in 1988 but became reinfested in 1989. A third significant infestation occupied some 62 000 ha along the United States border in the Rose Lake-Whitefish Lake-Middle Falls area of the southern Thunder Bay District.

Damage - Late season surveys for budworm-induced tree mortality revealed an increase of 529 155 ha within which mortality of balsam fir and spruce was evident. This brings the total area recorded during the current outbreak to 15 044 874 ha. All of the new mortality occurred in northwestern Ontario, with the largest increases in the Atikokan and Dryden districts where 279 445 ha and 110 420 ha of new mortality were recorded, respectively.

Control - The Ontario Ministry of Natural Resources aerially sprayed 30 516 ha with *B.t.* (Futura XLV) for control of spruce budworm in 1989. All of the area treated was in the Northcentral Region with 21 769 ha in the Nipigon District and 8747 ha in the Thunder Bay District. Areas treated included commercial forest, plantations, and a provincial park.

Monitoring - The annual spruce budworm egg survey sampled a total of 434 locations province-wide. A comparison of 329 locations sampled in both 1988 and 1989 showed an overall increase of 73% in egg-mass densities. On a regional basis, egg-mass densities declined by 3% overall in the Northwestern Region. This was a reflection of increases of 26% and 58%, respectively, in Dryden and Fort Frances districts and decreases of 8%, 6%, 12%, and 29% in Kenora, Ignace, Sioux Lookout, and Red Lake districts. In the Northcentral Region an overall increase of 179% was recorded. This was composed of a decrease of 25% in Atikokan District and increases of 516%, 171%, 701%, and 125% in Geraldton, Nipigon, Terrace Bay, and Thunder Bay districts.

Manitoba

Defoliation - Spruce budworm infestation increased significantly in 1989 in most of the outbreak areas reported in 1988, affecting a total of 58 016 ha of white spruce-balsam fir forests. Moderate to severe defoliation was evident in Whiteshell Provincial Park and in the Lake Wanipigow area. Light defoliation was observed in several spruce stands throughout the Interlake Forest Section, where close to 9600 ha were defoliated, and also in the Pineland (7252 ha) and Nelson (1295 ha) forest sections. Many of these were either new or expansions of infestations reported in 1988.

Control - An aerial *B.t.* spray program was implemented by the Manitoba Ministry of Natural Resources with coverage of nearly 4000 ha of commercial forest (Abitibi-Price F.M.A.) and about 1000 ha of high-use recreational forests (Whiteshell and Nopiming Provincial parks). Both

foliage protection and larval reduction were achieved.

Monitoring - In Manitoba, where the same sampling sites have been maintained since 1985, egg-mass densities were generally higher in 1989 than in 1988. These higher densities were paralleled by higher male moth catches in pheromone traps at several sampling sites.

Saskatchewan

Defoliation - Spruce budworm infestations in the Porcupine Hills in the east-central part of the province, remained at much the same level and extent as in 1988. Moderate to severe defoliation was evident in spruce stands near the Eldredge and McBride lakes, Tall Pines, Mann Lake, Usherville, and Big Valley. In the Red Earth outbreak, moderate to severe defoliation extended northwest to the Carrot River and south of Highway 55 into the Pasquia Hills. A portion of this outbreak in the area north of Highway 55 was logged out in 1989, with the exception of that part of the outbreak occurring within the Red Earth Indian Reserve. Timber harvesting is currently in progress in most of the remaining infestations.

Three new infestations were reported in white spruce stands in west-central Saskatchewan. Patches of light, moderate, and severe defoliation, respectively, were reported in the Taggart Creek area south of Sled Lake, near Pancake and Delaronde lakes, and north of Paradise Hill along the Monnery River.

The total area of spruce budworm defoliation in Saskatchewan in 1989 was 34 650 ha, slightly higher than the 31 600 ha recorded in 1988.

Alberta

Defoliation - In central Alberta, spruce budworm infestations caused light to moderate defoliation in white spruce stands in Big Knife Provincial Park (100 ha), near Castor (200 ha), near Millet (50 ha), along the Battle River valley between Camrose and Donalda (250 ha), and in the northeast section of Red Lodge Provincial Park (25 ha). Light defoliation was evident in some native spruce stands along the North Saskatchewan River between Edmonton and Devon.

In the Footner Lake Forest in northern Alberta, a notable increase in infestation area was reported in white spruce stands along the Chinchaga River and extending eastward. A total of 78 995 ha of light to severe defoliation was mapped in this area compared to 61 050 ha reported in 1988. In the Grande Prairie Forest about 1000 ha of moderate to severe defoliation occurred for about the fifth consecutive year in white spruce stands along the Peace River north of Eaglesham. In the Lac La Biche Forest, light to moderate defoliation was reported over an area of 4230 ha, an increase from 200 ha reported in 1988. In the Peace River Forest a new infestation was reported in the Hawk Hills over 1000 ha of white spruce forest.

Control - In the Grand Prairie Forest, the Alberta Forest Service conducted an experimental aerial spray trial over the 1000 ha with *B.t.* This experiment, the first of its kind attempted by the Alberta Forest Service, was to provide reduction of budworm defoliation and larval populations and to provide a training experience in aerial control technology. The post-spray results indicated some foliage protection was achieved, but it was lower than expected due to the late date of application (June 17).

Monitoring - Egg-mass density surveys were conducted by Alberta Forest Service staff in three outbreak areas in Alberta (Chinchaga River, Hawk Hills, and near Eaglesham).

Northwest Territories

Defoliation - The total area of spruce budworm infestation in white spruce stands markedly increased in 1989, to 98 600 ha as compared to 14 350 ha reported in 1988. The largest infestation extends along the Liard River from the Fisherman Lake - B.C. border area north to Fort Simpson, within which defoliation increased in both area and intensity in 1989. The most notable areas where moderate to severe defoliation occurred and increased were near the mouth of the Blackstone River, in the Petitot River area, and along Highway 7. Similar defoliation intensity was also evident along the Mackenzie River northwest of Fort Simpson through to the Martin River. Moderate defoliation occurred near the confluence of the North Nahanni and Mackenzie rivers and between Jean-Marie Creek and Highway 1.

In the Slave River outbreak areas, a general increase in intensity of defoliation was evident, but the overall size of area remained similar to that affected in 1988. Moderate to severe defoliation was present in spruce stands 10 km downstream from the junction of the Salt and Slave rivers, near Hook Lake, and in the Long Island area. Elsewhere, small pockets of light to severe defoliation were reported along the Slave River between Landry Creek and Pointe Emuveuse.

British Columbia and the Yukon

Current foliage of white spruce and alpine fir was lightly defoliated by eastern spruce budworm over 123 750 ha in more than 200 separate patches north and west of Fort Nelson in the northeastern part of the Prince George Region, a more than threefold increase from 1988. Defoliation again extended into the Yukon and Northwest territories and occurred for the fifth consecutive year in some areas around Fort Nelson. Defoliation was severe over about 10% of the area and light and moderate equally over most of the remaining area. High populations and severe defoliation were forecast to continue in 1990 in most previously infested stands, based on the high average number of egg masses which exceeded 100 per 1 m^2 of foliage at three sites and 13 per m^2 at two sites. There were no follow-up applications of B.t. in defoliated seed blocks near Fort Nelson, aerially sprayed by the British Columbia Forest Service in 1988.

Western spruce budworms *Choristoneura* spp.

British Columbia

The western spruce budworm *Choristoneura occidentalis* Free. is the most widely distributed and destructive defoliator of coniferous forests in western North America. Within British Columbia, despite the common name, it feeds primarily on Douglas-fir. Other currently active budworms in British Columbia include a 2-year-cycle budworm, *C. biennis* Free., and the eastern spruce budworm (*C. fumiferana* (Clem.)) in northeastern British Columbia.

Since 1900 at least six western spruce budworm infestations of varying duration have occurred at irregular intervals in southern British Columbia. The effects of defoliation include loss of radial and height growth, top-kill and resulting defects, and some tree mortality. In drier interior stands, where infestations culminated in more than 834 000 ha infested in 1986, mortality of open growing Douglas-fir near Cache Creek averaged 30-40% of the stems in long-term study plots. Decline in diameter increment in mature trees occurred one or two years after the first year of defoliation and increment has been almost nil since. In plots which had sustained 0 to 7 years of defoliation, tree mortality averaged 4.9% but varied widely (from 0 to 75%). A trend of increasing mortality with increasing years of defoliation is apparent.

The total area of defoliation of mixed-age Douglas-fir by western spruce budworm declined for the second consecutive year to 165 800 ha in the southern interior of British Columbia (Figure 2a,b) This is less than half the area affected in 1988.

More than 460 infested areas were aerially sketchmapped in 1989 and, of these, 95% were in the Kamloops Region, 11% in the Nelson Region, and 4% in the Vancouver Region. The intensity of defoliation was similar to 1988, with light on 79% of the area, moderate on 19%, and severe on 2%. The severe defoliation occurred mostly in the Shuswap Lake area, and near Vernon, Kelowna, Penticton, and, for the first time in this outbreak, in the southwestern part of the Nelson Region. Of the total area infested since 1983, 44% has been defoliated for 1 year, 32% for 2 years, 17% for 3 years, 5% for 4 years, and less than 1% each for 5 and 6 years.

Areas of decline, infested in 1988 but not 1989, totaled 248 000 ha in the eastern part of the Cariboo Region and continued in the North Thompson and Adams river drainages in the Kamloops Region. Although the infestation is declining overall, areas of expansion still totaled 54 000 ha and included the southwestern part of the Nelson, Bridge, and Fraser river drainages west and south of Lillooet in the Kamloops

Figure 2a: Area of defoliation by western spruce budworm in British Columbia, 1989.

Figure 2b: Area in Fig. 2a enlarged to show detail.

Region, and near Pemberton in the Vancouver Region.

Parasitism of late-instar larvae occurred at all 13 sites sampled and averaged 10% (range 1 to 22%). This was less than in 1988 and still too low to effectively reduce populations. The cause of the decline in the northern part of the Kamloops Region has been attributed again to larval starvation in chronically infested areas and possibly to the depletion of nutrient reserves of early-instar larvae following emergence during a prolonged warm dry spell in 1987. In the eastern part of the Cariboo Region, mid- to late-instar larvae were also diseased.

Control - In a joint British Columbia Forest Service - Forestry Canada aerial spray trial, *B.t.* (Dipel® 264) was applied to *C. occidentalis* Free. populations at ultra-low volumes over 150 ha west of Westbank in the Kamloops Region. In laboratory feeding trials using the sprayed foliage, 86% of the larvae were killed after 6 days. Budworm populations in defoliated Douglas-fir over 100 ha near Johnstone Creek in the Nelson Region were sprayed by the British Columbia Forest Service (BCFS) for the second consecutive year. Spraying of previously treated blocks elsewhere in the Kamloops Region by the BCFS was discontinued, and shifted to the Okanagan Valley, with 200 ha sprayed west of Kelowna (TFL 49) and 100 ha near White Lake north of Salmon Arm.

As part of a study to improve and calibrate detection methods for western spruce budworm, mid- to late-instar budworm larvae and adult males were monitored at 10 sites still with low populations but with a history of budworm outbreaks. Up to 17 larvae per tree were collected per 1-m^2 beating (3 branches on 25 trees per plot) and up to 840 male adults were caught in "Multipher®" traps. Further analysis and additional sampling are necessary before numbers can be correlated with population potential and damage.

Defoliation of spruce and alpine fir forests by 2-year-cycle budworm *Choristoneura biennis* Free. was very light over 17 000 ha in 55 infestations in four forest regions. This was down from 102 000 ha in 1988, a feeding year, and from 59 750 ha in 1987 which was largely a non-feeding year. Immature 'on-cycle' budworm defoliated new buds on spruce and some fir over 4200 ha in

the Prince George Region, 2800 ha in the Cariboo Region, and 300 ha in the Kamloops Region. Mature 'off-cycle' larvae defoliated spruce and alpine fir in about 15 high-elevation areas in the Kamloops and Nelson regions totalling 9800 ha, and probably an additional 11 385 ha in the Ospika River drainage north of Mackenzie in the Prince George Region. Taxonomic and pheromone studies are in progress to more accurately determine the species in the Ospika drainage.

In eastern and southeastern parts of the Prince George Region, new shoots of white spruce and alpine fir were infested and lightly defoliated over 4200 ha in 19 separate areas along the Bowron Coal Road, in the Everett and Tumuch creek drainages, and near Slim and Stoney lakes. This was down from 88 separate infestations in 1988, the mature larval feeding year.

Defoliation of Engelmann spruce and alpine fir in northeastern parts of the Cariboo Region was light in 15 areas totalling 2800 ha, mostly between Canim and Horsefly lakes, and west of Barkerville in the Willow River Valley. This was down from 1988 when mature larvae defoliated more than 240 stands over 40 215 ha.

In the Kamloops Region, six separate spruce-fir stands in the North Thompson River drainage totalling 300 ha, were lightly defoliated. This was down significantly from 159 areas totalling 42 250 ha of mostly light defoliation by mature larvae in 1988.

Defoliation by immature 'on-cycle' larvae is forecast to continue in 1990, based on the number of infested buds and some year-old egg masses in parts of the Prince George, Cariboo, and Kamloops regions.

Maturing 'off-cycle' budworm lightly defoliated new shoots of high-elevation spruce and fir over 9800 ha in 15 areas in the Nelson and Kamloops regions. These included Plant and Barnes creeks in the Arrow Lakes TSA, Bugaboo Creek and the St. Mary River drainage in the Nelson Region, and the Upper Kettle River Valley in eastern Kamloops Region.

Larvae and adult male populations continued to be monitored in four regions to improve identification and calibrate methods to detect budworm populations in spruce-fir forests. Up to 247 adult males (average 118) were collected in "Multipher®" traps at five locations in two regions, and up to 4000 in "Universal®" traps at 16 locations in four regions. Further study is necessary before the numbers can be correlated with population damage and potential.

Monitoring - Egg sample assessments at 37 locations in three regions were 10% more numerous than in 1988. Increases occurred at five sites in the Okanagan Timber Supply Area (TSA), at four sites in the Kamloops TSA, one near Lytton, at six sites in the southwestern part of the Nelson Region including near Bridesville, Johnstone Creek, and Anarchist Mountain, and at two sites east of Pemberton in the Vancouver Region.

Western blackheaded budworm
Acleris gloverana (Wlshm.), and Hemlock sawfly
Neodiprion tsugae Middleton

British Columbia

Western blackheaded budworm has caused extensive defoliation, top-kill, and some tree mortality in western hemlock forests in British Columbia periodically since the 1940s. Infestations occurred in coastal forests of all ages on northern Vancouver Island and the Queen Charlotte Islands in the mid-1940s, the 1950s, and early 1970s. Flareups have occurred in interior, usually overmature, wet belt forests in the mid-1950s, the 1960s, and the 1980s, but these have subsided without appreciable damage. Hemlock sawfly is a common associate of budworm and may follow budworm infestations.

Following four consecutive years of feeding in hemlock stands on the Queen Charlotte Islands, blackheaded budworm and hemlock sawfly *Neodiprion tsugae* Middleton populations collapsed. However, on northern Vancouver Island, western hemlock was defoliated over 7400 ha, up from 4800 ha in 1988; some areas were defoliated for the third year. Defoliation was surveyed in 124

areas near Holberg; it was severe for the first time in eight areas totalling 1100 ha, moderate in 16 areas covering 3950 ha, and light in 2350 ha. In the eastern part of the Prince Rupert Region, new shoots on alpine fir were moderately defoliated over about 65 000 ha, up from 58 000 ha in 1988, the most widespread defoliation since the first record in 1982.

Parasitism of blackheaded budworm larvae on northern Vancouver Island averaged 13% (range 1 to 51%), which is considered too low to significantly reduce the population. Egg samples at 16 sites near Holberg averaged 14 eggs per 45-cm hemlock branch. The last recorded infestation on Vancouver Island, from 1970 to 1973, defoliated western hemlock and amabilis fir over 164 000 ha from Jordan River to Holberg. Top-kill was limited to 10% of the trees in small areas on southern Vancouver Island, but tree mortality did not occur.

Surveys of western hemlock stands on the Queen Charlotte Islands, following four consecutive years of defoliation by both blackheaded budworm and hemlock sawfly, found tree mortality to be widespread and patchy, averaging 29% (range 0 to 94%) of the 20- to 45-year-old hemlock affected.

A commercial formulation of *B.t.* (Dipel® 176), was applied aerially to budworm larvae in western hemlock in three blocks totalling 108 ha near Holberg. The cooperative study between Western Forest Products Ltd., the British Columbia Forest Service, and Forestry Canada found that an average of 52% of larvae that fed for 6 days on the sprayed foliage were killed.

the declining phase of hemlock looper outbreaks. High population levels are generally concentrated on current foliage in the upper portion of the crown and outbreaks usually subside after about 2 to 3 years without causing tree mortality. Parasites play a major role in the collapse of these infestations.

In 1989 the infestation continued to increase in size and severity to over 35 000 ha, extending across the Northern Peninsula from St. Barbe to Main Brook. High numbers of larvae, up to 315 per tree sample (avg. = 45.3), were collected throughout the infestation. Moderate and severe defoliation occurred throughout the crowns, mainly in overmature stands, and only light defoliation occurred in the precommercially-thinned stands. Larval parasitism increased to 16% by hymenopterous parasites plus 8% by dipterous parasites in 1989. However, levels of parasitism are still low and the outbreak will likely continue. In several areas this budworm was feeding along with the hemlock looper, with both insects contributing to tree mortality. A small infestation on the Avalon Peninsula collapsed in 1989; presumably parasitism was the major factor.

A spray program planned for the Northern Peninsula in 1989 against the hemlock looper was not as successful as expected because in some areas the blackheaded budworm had caused considerable defoliation before the hemlock looper had emerged and before the sprays were applied.

Monitoring - Branch samples were collected in the fall at 135 locations throughout the infestation to estimate overwintering egg population levels.

Blackheaded budworm
Acleris variana (Fern.)

Newfoundland

The blackheaded budworm has been considered a minor pest in Newfoundland since it was first recorded in 1938. Infestations generally occur at intervals of 10 years and usually overlap

Jack pine budworm
Choristoneura pinus pinus Free.

This close relative of the spruce budworm has long been regarded a serious pest of jack pine stands and plantations in northwestern Ontario, Manitoba, and Saskatchewan, and the Great Lakes States of the U.S.A.

Ontario

Defoliation - Substantial population declines resulted in a marked reduction in the area of moderate to severe defoliation, from 737 482 ha in 1988 to 248 311 ha in 1989 (Figure 3). All the defoliation occurred in the Red Lake and Sioux Lookout districts. The largest infestation, 165 716 ha, was located in the northern Red Lake District between the Berens River and Nungesser Lake. Large areas to the north of this infestation, defoliated in 1988, were completely burned off by wildfires in the fall of 1988 and spring of 1989. Four other pockets ranging from 325 to 12 039 ha were mapped between Coathup Lake and the southwestern shore of Trout Lake. Two pockets of infestation 37 682 ha and 2448 ha in size straddled the Red Lake-Sioux Lookout district boundary in the Aerofoil Lake and Perrigo-Wakeman lakes areas. Three other pockets of defoliation were recorded in Sioux Lookout District near Christina Lake (5584 ha), Brokenmouth Lake (2700 ha), and Kesaka Creek (6865 ha). Throughout much of the areas described above, defoliation was moderate rather than severe but individual trees and small clumps of trees sometimes supported very high populations.

Damage - There was little apparent change in the amount of top killing and tree mortality within the jack pine budworm infested areas. At one location north of Stormer Lake, Red Lake District, mortality increased from 9% in 1988 to 10% in 1989 and dead/bare tops at the same location increased from 21% to 28%.

Control - In June, OMNR aerially sprayed 4763 ha of jack pine forest in the English River area of Thunder Bay District. The area received three applications of *B.t.* between June 17 and 29. In addition, Canadian Pacific Forest Products Limited harvested 200-250 ha of the most heavily infested timber. Subsequent aerial surveys did not detect any defoliation and egg-mass counts were low.

Monitoring - Jack pine budworm egg-mass sampling was conducted in late August at a total of 108 locations. A comparison of 69 locations sampled in 1988 and 1989 showed a reduction of 72% in overall egg-mass densities.

Prairie Provinces

In Manitoba, the jack pine budworm was not detected in the province for the second consecutive year. Previous outbreaks spanned a period of six years, from 1982 to 1987. Pheromone traps were placed at 12 locations throughout the range of jack pine budworm in Manitoba by the Forestry Branch of the Manitoba Department of Natural Resources (MNR) and indicate a small increase in male moth captures in 1989 compared to 1988 captures. This may signal the start of a new outbreak. Foliage samples were also collected by the MNR to assess defoliation, egg-mass, and staminate bud production.

In Saskatchewan, endemic populations were reported in some areas of the Nisbet, Fort a la Corne, and Torch River provincial forests. No new outbreaks were reported in the province.

In Alberta, populations of the jack pine budworm caused light defoliation in jack pine stands in the Tawatinaw-Clyde area. There was no change in the size of the infestation (70 ha) in 1989 from that reported in 1987 and 1988.

Mountain pine beetle
Dendroctonus ponderosae Hopk.

Lodgepole pine is the principal host of the mountain pine beetle, but several other western pine species are susceptible. The beetles attack trees in mid- to late summer and infect them with several microorganisms, including blue stain fungi. Eggs laid by female beetles yield larvae that feed on the inner bark. Infested trees generally die from the combined action of blue stain fungi and the beetle larvae. The foliage of killed trees usually turns red-brown in the year following attack and tree mortality can then be detected by aerial surveys.

Because most beetle-killed trees are of suitable size for saw logs, the monetary loss in commercial forests can be significant if trees are not salvaged quickly. Other consequences are a hastening of

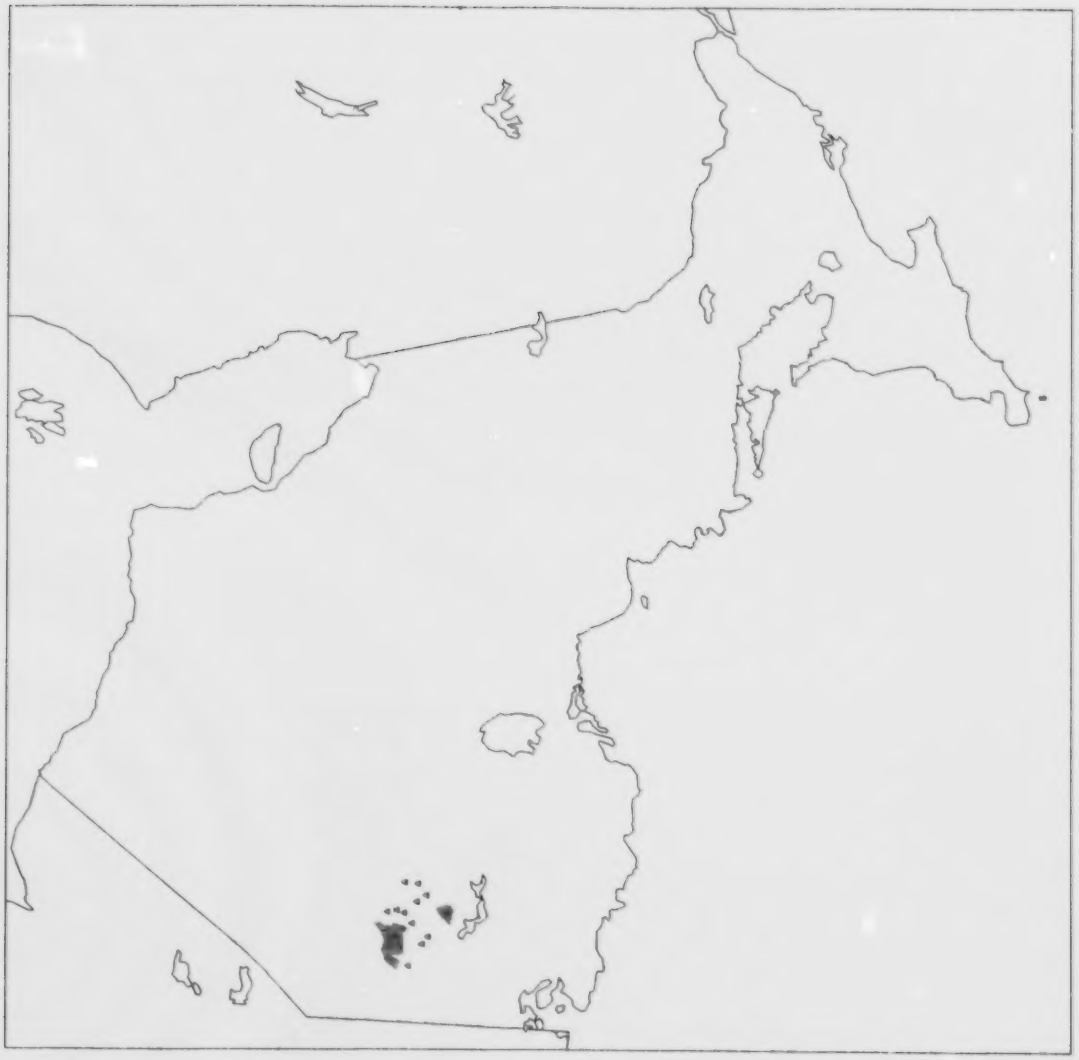

Figure 3. Areas of moderate to severe defoliation caused by jack pine budworm in 1989.

forest succession, a change in age and diameter distribution of the pine component of forests, a reduction in aesthetic values, and an increase in fire hazard. Each of these effects can force disruptive and costly changes in forest management plans. Many companies have shifted operations to concentrate on salvage of recently killed trees, particularly in British Columbia where large volumes of dead trees are involved.

British Columbia

Mountain pine beetle continues to be the most destructive forest insect in British Columbia. Outbreaks have been recorded at varying geographic locations within British Columbia and Alberta at irregular intervals since at least 1910. The current series of outbreaks started during the late 1960s and early 1970s. The area of newly red trees (attacked the previous year and often called faders) increased each year until 1984, with very rapid increases in the early 1980s. Cumulatively, over 210 million mature pine have been killed and harvesting plans throughout the Province have been severely affected.

The area and volume of lodgepole pine and some white pine killed by mountain pine beetle in 1989 declined overall by about 15% to the lowest level since 1977. However, more than 8625 infestations are still active on more than 53 530 ha from the international border south of Cranbrook to north of Terrace (Figure 4). This is more than twice the area burned by forest fires in British Columbia in 1989 and represents about 5% of the annual lodgepole pine harvested.

Declines in areas infested, due primarily to host depletion including harvesting, occurred in five regions. These include the Cariboo Region (down nearly half to 700 ha), the Kamloops Region (down more than 30% to 12 100 ha), the Prince George Region (down 30% to 2800 ha), the Prince Rupert Region (down more than 50% to 5400 ha), and the Vancouver Region (down 35% to 550 ha). Infestations increased in the Nelson Region by 28% to over 31 800 ha, mainly south of Cranbrook and north of Beaverdell.

Overwintering brood mortality assessed in 50 major infestations in six forest regions in early 1989 was generally less than 10%, but exceeded 75% in higher-elevation stands in southeastern British Columbia. At 64% of the locations, the

Figure 4. Mountain pine beetle mortality in British Columbia, 1989.

ratios of progeny to parents was greater than 4.0, indicating increasing populations for flight and attack in July. In September, new attacks averaged 17% of the trees in 35 stands, and were higher than last year in five regions, but down slightly in the Nelson Region. Still, the highest regional average was in the Nelson Region at 24% and ranged from 13 to 17% in the remainder.

In the Cariboo Region, pine mortality declined by nearly half to 700 ha near Chilko Lake and remained low elsewhere in the region. The area of mature pine killed by the beetle in 1989 in the Kamloops Region contained 1.2 million trees (620 000 m^3). The decline, largely due to host depletion, occurred mainly east of Kelowna. White pine mortality was again numerous in the northern part of the region from Vavenby to Alberta.

Mountain pine beetle infestations in the Nelson Region contained 1.6 million trees (591 000 m^3). An additional 20 000 trees were killed over 700 ha in Kootenay, Glacier, and Mt. Revelstoke National Parks. Although the number of infestations along most of the British Columbia-Alberta border and in the southern part of Kootenay National Park declined further, those near Sparwood, Cranbrook, and Beaverdell increased again and, regionwide, totalled more

than 5300. Newly attacked trees decreased slightly overall to an average of 24% in 22 stands mostly in the East Kootenay, with the highest at Horsethief Creek (42%) and Moyie Lake (38%). New attacks declined in the West Kootenay to an average of 13%, the highest in the Kettle River Valley north of Beaverdell.

The area of lodgepole pine killed by the beetle in the Prince Rupert Region declined for a second consecutive year to 5400 ha containing 4 000 000 recently killed trees (240 000 m^3). The major decrease occurred mainly in the Nilkitkwa, Kispiox, and eastern Skeena river valleys in the central part of the region. Tree mortality is forecast to continue in the western part of the region, where 17% of the trees were newly attacked in 1989 (range 6 to 28%).

Infestations declined about 30% in the Prince George Region to 2800 ha (122 000 trees, 98 000 m^3), mostly northwest of Fort St. James. Current attacks averaged 14%. Pine beetle control operations in Mt. Robson Provincial Park continued for the fifth consecutive year, with about 234 beetle-attacked trees to be treated.

The total area containing recently killed pine in the Vancouver Region declined by nearly half for the second consecutive year to 555 ha (14 000 trees, 10 000 m^3), and the number of infestations declined by 22%. A further decline is forecast in 1990, due to the very limited remaining susceptible host material.

Funding of a special 5-year program by the B.C. Forest Service, which totalled $37 million in 1988, was allocated towards extraction of beetle-infested stands and increased control actions such as pheromone-baiting trees and cut-and-burn programs.

Salvage of beetle-killed and adjacent susceptible pine continued at high levels in most beetle-infested Timber Supply Areas. Salvage harvesting of economically accessible beetle-killed pine may result in a reduced annual allowable cut in the near future.

Alberta and Saskatchewan

Infestations of the mountain pine beetle in 1989 remained at low levels in southwestern Alberta and Saskatchewan, and in the Rocky Mountain national parks, except in Kootenay Park, British Columbia.

Aerial and ground surveys conducted in Jasper National Park in 1989 revealed no evidence of dispersal of mountain pine beetle in the park. Infestations have been reported west of the park, in Mt. Robson Provincial Park, for the past several years, but the risks of population buildup and eastward dispersal of beetles have been minimized by annual monitoring and sanitation control treatments applied in the area between Jasper National Park and Valemount, B.C.

No surveys were conducted in Banff National Park; no beetle-killed trees had been observed in 1988. In Yoho National Park, about 15 scattered trees, presumably killed by the mountain pine beetle in 1988, were mapped south of Emerald Lake. A patch of about 30 trees, presumably killed by this beetle, was also observed near the south end of the park. Other scattered single dead trees occurred along the lower slope of Mt. King and are believed to have died from porcupine girdling.

In Kootenay National Park, aerial surveys were conducted in cooperation with Canadian Parks Service and the Pacific Forestry Centre. No new areas of infestation were mapped outside of those recorded in 1988. The total number of trees recently killed within the park is probably similar to or slightly higher than that reported last year (an estimated 3800 trees in 1988).

In Waterton Lakes National Park, an estimated 20-30 scattered recently killed lodgepole pine, presumably killed by the mountain pine beetle, were observed adjacent to Cameron Lake road and Blakiston Creek.

In southwestern Alberta, at least 600 recent MPB-killed lodgepole pine in over 400 sites were mapped by the Alberta Forest Service. These occurred either singly or in small groups of 2-10 trees and were scattered throughout the Porcupine Hills, south to Waterton Lakes National Park. The number of infested trees mapped this year reflects an increase over the last three years, likely due in part to immigration of beetles from expanded infestations in adjacent southeastern British Columbia.

Semiochemical tree baits were deployed by the Alberta Forest Service at 13 locations in the southern Bow-Crow Forest and at 12 locations in Kananaskis Country east of Banff National Park. The baits have been used annually since 1983 as part of a detection and monitoring program. Attacks occurred at 11 of 13 baiting sites in the southern Bow-Crow Forest and at nine of the 12 baiting sites in Kananaskis Country. Most of the attacks, however, were "pitched out" or unsuccessful and did not necessitate tree removal by sanitation cuttings.

Semiochemical baits deployed in the Cypress Hills in southwestern Saskatchewan and adjacent Alberta indicated a continued declining trend in mountain pine beetle populations. Of the 200 trees baited in each provincial portion of the Cypress Hills, only nine attacks were recorded on seven trees on the Alberta side and one attack on the Saskatchewan side. About 180 recently-killed lodgepole pine were detected during aerial and ground surveys in Saskatchewan, and most occurred around the perimeters of recent patch cuttings. No beetles were found associated with the large number of these dead trees that were sampled, but associated populations of the pine engraver (*Ips pini* (Say)) were common.

As a result of a long-term forest harvesting plan recently initiated in the Saskatchewan portion of the Cypress Hills, 22 patch cuttings covering a total area of 250 ha have now been completed. This program was instituted with the main objective of gradually removing the overmature even-aged lodgepole pine stands that are now declining and replacing them with a progression of younger age classes widely distributed in relatively small areas.

Spruce beetle
Dendroctonus rufipennis (Kby.)

The spruce beetle belongs to a genus of bark beetles that periodically cause significant mortality to the conifer forests of Canada. It infests all species of spruce in Canada, with white spruce and Sitka spruce the primary hosts. The annual mortality attributable to the spruce beetle is difficult to assess because much of the mortality, except for outbreaks, originates from scattered single or small groups of trees. Populations are normally endemic in forest debris and overmature timber. However, stand disturbances such as blowdown, cull, or right-of-way logging operations create breeding material which facilitates population buildup. Under outbreak conditions, attacks can occur on pole-sized, immature timber, and on atypical hosts such as lodgepole pine when these are mixed with the primary hosts.

British Columbia

The area and volume of mature white and Engelmann spruce killed by the spruce beetle in British Columbia declined overall for the seventh consecutive year; however, local populations increased north of Prince George, southeast of Bella Coola, and in the East Kootenay. Host depletion, salvage, and sanitation contributed to the decline. Most of the 1000 ha of infested spruce mapped in aerial surveys, down from 1675 ha in 1988, were in about 118 separate infestations mainly in the Kamloops and Prince George regions.

In the Kamloops Region, recent mortality of mature spruce by spruce beetle was again confined mostly to previously infested stands in nine pockets totalling 905 ha, similar to 1988. Spot infestations of two to 10 trees occurred in the Fraser Canyon, and near Princeton and Barriere. Older infestations in the Tulameen River drainage declined further, primarily from harvesting, to 24 ha from 430 ha in 1988.

Beetle populations in the Nelson Region were mostly in small scattered pockets of blowdown at the heads of drainages in the East Kootenay, down overall from 225 ha in 1988. Broods in 1988-attacked spruce west of Kimberley pose a threat to adjacent standing spruce in the future. New attacks averaging six per 500 cm^2 of bark sampled in recent blowdown east of Cranbrook and Canal Flats and north of Golden, indicate very light attacks in 1991. Beetle broods in bolts at the southern boundary of Glacier National Park were partially reduced by "drying out" treatment.

Local populations increased near Weedon, Kerry, and Davis lakes north of Prince George,

mostly in recent windthrow and in standing spruce, and they pose a threat to adjacent stands. New beetle attacks in recent blowdown in the McGregor and Table river drainages east of Prince George are a potential threat to adjacent spruce.

East of Bella Coola in the mid-coast part of the Vancouver Region, mature Sitka spruce in a 5-ha pocket were attacked by spruce beetle, which could pose a threat to adjacent standing trees in the future.

Beetle populations in spruce along the Haines Road in the northern part of the Prince Rupert Region have been effectively reduced to endemic levels by control programs including salvage and strip debarking of felled trees.

Timely salvage, sanitation, and host depletion should maintain present populations mostly in scattered windthrow, corridors, log decks, and butts of mature and overmature standing trees.

Maritime Provinces

The spruce beetle remained active throughout the Maritimes in 1989 and white spruce mortality occurred in all three provinces.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then, the insect has been found in a number of widely separated areas, mostly in the southeastern and northwestern parts of the province. Spruce beetle populations declined sharply in 1988 from levels of previous years and no newly infested trees were found at any of the known infestation areas, including those with the longest history, and only a single infested tree was found in Restigouche County.

In 1989, spruce beetle activity increased sharply and both dead and newly infested white spruce trees were observed at a number of locations in the Meridian Brook area and in the Christmas Mountain range in northwestern Northumberland County. These infestations appear to have started near the bottoms of brook valleys and are now spreading upward along the valley slopes. Other nearby valleys may also be similarly affected but access is poor and ground observations difficult. A few newly infested trees were found along the Shepody Road in Fundy National Park and at Cains River, Sunbury County.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and, by the end of 1983, no large areas remained without severe white spruce mortality. Beetle activity decreased between 1984 and 1986 on Cape Breton Island, but there was an increase in the number of spruce beetle-attacked white spruce on the mainland. The level of insect activity remained the same in 1987 and 1988, with most of the tree mortality occurring on Cape Breton Island and on the northern mainland. However, trees were also dying in small, scattered pockets in other areas of the Province.

In 1989, white spruce mortality, caused by new infestations, decreased on Cape Breton Island; however, there was an increase on the mainland. Most of the damage, averaging 30% in the stands examined, occurred in Antigonish, Pictou, Kings, and Annapolis counties but small, scattered pockets of infested trees were also observed in Colchester, Digby, Lunenburg, Queens, and Inverness counties.

In Prince Edward Island, spruce beetle killed an estimated one-third of the merchantable white spruce by 1983 when infestations peaked. Populations then have decreased steadily and in 1986 only a very few newly infested white spruce trees were observed in the Province. There was an increase in infestations in 1987 and a further increase in 1988. In 1989, populations have apparently decreased and newly infested white spruce trees were found only at Caledonia, Kings County where, in a 20 ha stand, about 5% of the trees were freshly attacked in addition to 5-10% of the trees already dead. Old-dead trees were observed in other areas.

Eastern larch beetle
Dendroctonus simplex Lec.

This insect normally attacks only weakened, damaged, or recently felled host material. However, when populations are very high, the insect can also attack living, apparently healthy, mature or overmature trees. Even younger, small diameter trees can become infested.

Maritime Provinces

A population buildup was first noticed in Nova Scotia in 1976. This increase in beetle population followed several years of severe defoliation or larch by the larch sawfly *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 64% of merchantable-size larch were dead in Nova Scotia, 24% in New Brunswick, and 13% on Prince Edward Island. Insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1989, populations of this bark beetle remained generally low and few trees became infested or died as a result of attack. The exception was a small outbreak on the campus of the University of New Brunswick at Fredericton, affecting about 40% of the larch trees and resulting in a sanitation cut. Elsewhere a few mature and overmature trees became infested and some died in scattered areas in St. John, Westmorland, and Victoria counties in New Brunswick in Cumberland, Hants, and Annapolis counties in Nova Scotia and at three locations in Prince County in Prince Edward Island.

Two trees became infested and two trees died at the central New Brunswick research plot in 1989. The infestation rate of 1.9% in 1989 contrasts with the peak year of 1987, when the infestation rate was 7.6%. Cumulative larch mortality due to attack by the eastern larch beetle has increased from 6% in the spring of 1979, when the plot was established, to 41% in 1989, an average of 3.2% annual tree mortality during those years. (Total tree mortality reported here is lower than mortality reported last year for 1988 and is the correct figure. A recalculation of the data necessitated this change).

Gypsy moth
Lymantria dispar (L.)

The gypsy moth has for decades been the most destructive insect of hardwoods and, to a lesser degree, of conifers in the northeastern United States. Female moths are flightless, limiting the spread of this pest to dispersal of the minute early-instar larvae on air currents or to artificial transport as eggs or larvae on human conveyances.

Trapping male moths with pheromone traps has become a common practice throughout Canada. Trapping information is used to help detect the gypsy moth, define where local populations may be found, and to assist the search for other life stages. No moths were trapped in Newfoundland or the prairie provinces in 1989.

Maritime Provinces

After its reappearance in the Maritimes in 1981, the gypsy moth gained further ground in 1989. The gypsy moth appears to be established in both New Brunswick and Nova Scotia and, in 1987, caused visible defoliation in the Region for the first time in nearly half a century. The status of the outbreak in Maine has been of special concern because of its proximity to the Maritimes. In 1989, gypsy moth of defoliation in Maine increased from 40 ha in 1988 to 13 850 ha.

The gypsy moth monitoring committee remained active in 1989, and again coordinated surveys. This committee of many organizations, involving all levels of government, was formed in response to the discovery of gypsy moth in 1981 and was an effort to utilize available manpower more efficiently in combating the threat to the forests of the Region.

In 1989, early season egg-mass surveys, larval surveys, the adult trapping program, and late fall egg-mass surveys were conducted to determine the current status of the insect in the Region and to effect control in designated areas.

The adult male trapping program is aimed at defining areas where searching for egg masses should be concentrated. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate, or at least to minimize, interference from large numbers of male moths brought into the Region by weather fronts from infested areas in the United States. Survey traps are now placed in late July. Control traps are also placed at the beginning of July. Data was obtained from 7263 traps in the Region, 2945 in New Brunswick, 3979 in Nova Scotia, and 339 in

Prince Edward Island, representing a 95% trap return. The high return, because of better understanding by cooperators of the value of negative results, greatly aided the planning of fall egg-mass surveys.

In New Brunswick, gypsy moth larvae, egg masses and/or pupae were found during egg-mass surveys at 11 locations. The total number of areas where gypsy moth has been found at least once since 1981 is 48. However, only eight of these areas are outside Charlotte County and, with the exception of Fredericton, McAdam, and Forest City, the gypsy moth has been found only once at any of these locations. In Saint John, an unemerged pupa was found in 1981 and the lack of any activity in this area since then suggests that this was a larval introduction rather than an egg mass. A similar situation is suspected in the area near Peel, Carleton County, where two years of extensive trapping and searching have failed to confirm the presence of gypsy moth.

Over 80% of the known gypsy moth locations in New Brunswick are in Charlotte County and all but one of the 11 areas where gypsy moth was found in 1989 are in the western half of the county or in areas adjacent to it in southwestern York County. In view of this, the western half of Charlotte County of New Brunswick is considered to sustain a generally low level but widespread population of gypsy moth, both in forest and, at least in the case of St. Andrews and St. Stephen, in urban settings. However, the nine positive locations in 1989 represent only 3% of the 300 areas searched for egg masses in Charlotte and southwestern York counties, indicating low gypsy moth populations.

In Nova Scotia, gypsy moth was found at 15 locations, all in the western half of the Province. All but one of the areas were either the same or adjacent to areas where the insect had been found in previous years. The exception was a location near Lake Paul, Kings County, where a single early instar larva was found on a maple tree. Egg masses were not numerous in most areas but, even in areas where egg mass counts were relatively higher, little noticeable defoliation occurred in 1989. It is worth noting that gypsy moth was not found in several areas where egg masses were present in previous years and that, with the exception of Lake Paul, all positive locations are the same as in 1988.

In Prince Edward Island, the gypsy moth is not known to occur to date. There were only 21 male moths caught in the 339 pheromone traps in the Province. Most were single catches, no more than three males were captured in any of the traps, and no egg masses were found at any of these locations.

In New Brunswick, most of the gypsy moth locations are in forested areas, away from habitation, and are concentrated in a small section of the Province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia, almost all of the infested spots are inhabited areas with considerable movement of people. This suggests that, while in New Brunswick the presence of gypsy moth, in most places, may be the result of natural spread, in Nova Scotia the insect was likely imported by commercial traffic, visitors or residents travelling in gypsy moth-infested areas.

Control - Control operations against the gypsy moth in 1989 were conducted at a number of clearly defined locations in accordance with federal-provincial agreements with the provinces of New Brunswick and Nova Scotia. At most locations, controls in 1989 consisted of trap-out or "heavy" trapping programs to lower male moth populations in advance of mating and to better define areas of infestations in advance of the 1990 programs. Moth catches in areas of repeated trapping were generally much higher than in previous years, possibly indicating an intensification of infestations. However, gypsy moth outbreaks in the United States were more extensive than during the past few years, weather patterns in 1989 were markedly different from those in 1987 and 1988, and the limited number of daily observation traps indicate that at least some of the gypsy moth males captured in the Maritimes in 1989 were blown-in and originated in areas remote from the capture points.

Québec

The activity of the gypsy moth increased this year, in terms of both distribution and severity of damage. Damage was observed over 5850 ha in the Outaouais region, compared with 1260 ha in 1988. Areas in which defoliation was estimated to be severe were reported over 2475 ha in 1989, whereas only 300 ha were severely defoliated in 1988. Areas of moderate defoliation totalled

2225 ha. Red and white oak are the preferred hosts of the gypsy moth and damage was observed along the Outaouais River. North of Ile des Allumettes, between Sheenboro and Nicabong, an area of roughly 50 ha is lightly defoliated and an area of roughly 30 ha is severely defoliated. For the third consecutive year, oak stands on the Eardly escarpment in Gatineau Park were severely defoliated. Once again, this is the main pocket of defoliation by gypsy moths in Québec. It is approximately 1750 ha in area, of which 1175 ha is severely defoliated and 225 ha moderately defoliated.

North of Gatineau Park, as far as East Aldfield, small areas no larger than roughly 20 ha have been affected by gypsy moths. They were observed in 1989 between Montebello and the Gatineau River. There were many small pockets of defoliation ranging from 20 to 100 ha, scattered primarily in the Vallée de la Nation and in the Lièvre and Gatineau river basins. However, there were two larger pockets located near Notre-Dame-de-la-Salette. They were 175 ha and 250 ha in area respectively, and the damage observed was mainly moderate.

In the Montréal region, sightings of the insect were reported a number of times, although very few were of any significance. The main damage was observed on Rigaud mountain where roughly 15 ha of red oak were lightly defoliated.

The Laurentian Forestry Centre (now Forestry Canada - Québec Region), in cooperation with Agriculture Canada's Plant Protection Division, continued the survey of male gypsy moths. The areas monitored were Victoriaville - Lotbinière and Drummondville. The survey results reveal that an average of 15.4 male moths were caught in traps this year, compared with 10.8 in 1988. The number of moths captured increased primarily in the Drummondville sector, where an average of 18.9 moths were captured per trap.

Ontario

Defoliation - High populations caused an increase in moderate to severe defoliation for the second consecutive year with a total area of 81 460 ha affected, compared to 29 693 ha in 1988 (Figure 5). Most of the increase and defoliation occurred in the Tweed, Brockville, and Napanee districts where the insect has been established longest; however, sizeable increases were also recorded in the Lindsay and Simcoe districts. Small increases were recorded in the Niagara and Pembroke districts and a slight reduction in the area of moderate to severe defoliation occurred in the Bancroft and Carleton Place districts. A general population increase characterized by small numbers of larvae and light infestations was evident at many other locations in southern Ontario.

Figure 5. Occurrence of gypsy moth in Ontario, 1989.

Burlap trapping - A burlap larval trapping program was carried out at most provincial parks and campgrounds in southern Ontario with the following results. In the Eastern Region, larvae were caught at 10 of 12 parks with increases recorded in nine of these. The highest number of larvae, 2159, were captured at Sharbot Lake Provincial Park. Trapping in the Algonquin Region yielded small numbers of larvae at 9 of 23 locations compared with 7 of 23 locations in 1988. In the Central Region, larvae were caught at 15 of 16 locations, with increased numbers recorded over 1988 levels at 14 locations. The largest catch was at Balsam Lake Provincial Park where the number of larvae increased from 17 in 1988 to 489 in 1989. In the Southwestern Region positive results were recorded at 7 of 11 parks compared with 3 of 11 parks the previous year. The largest number of larvae were caught at Selkirk

Provincial Park where 1040 were recorded compared with 17 in 1988.

Pheromone trapping - A pheromone trapping program was carried out at most provincial parks and campgrounds in northern and southern Ontario as well as at the Canadian Forces Bases at Borden and Petawawa and the Meaford Tank Range.

In southern Ontario, adults were captured at all 64 parks where traps were deployed and recovered as well as at the military locations. Increases in the number of male moths captured were recorded at 54 of the 64 parks as well as at the military bases. Catches at the 10 other locations either declined or remained unchanged.

In northern Ontario, adult moths were captured at 15 of 16 parks in the North Bay, Sudbury, Blind River, and Espanola districts. These results were not unexpected as the insect continues to expand its range northward. In the remainder of northern Ontario, three moths were caught at Kap-Kig-Iwan Provincial Park in Kirkland Lake District and at Agawa Bay in Lake Superior Provincial Park, Wawa District. Single moths were caught at Rabbit Blanket Lake, in Lake Superior Provincial Park, Wawa District, at Pancake Bay Provincial Park, Sault Ste. Marie District and at Blue Lake Provincial Park in Dryden District.

Control - The Ontario Ministry of Natural Resources aerially sprayed a total of 12 951 ha comprised of 1176 ha of crown land and 11 775 ha of private land with *B.t.* Futura XLV. The purpose of spraying was to minimize defoliation.

Egg surveys - Gypsy moth egg surveys were carried out by several agencies including OMNR, FIDS, and municipal authorities. An analysis of the combined results provides a forecast of how gypsy moth infestations may develop in 1990. Infestations were expected to expand and intensify in eastern Ontario, with the largest infestation extending from the north shore of the St. Lawrence River in the Brockville area, north and west through large parts of the Napanee, Brockville, Tweed, Lindsay, and Minden districts. Sizeable but more discrete infestations will probably develop at several locations in the Carleton Place, Niagara, Maple, and Simcoe districts. Smaller pockets of heavy infestation were expected at several locations in the Pembroke, Maple, Huronia, and Parry Sound districts and at many locations in Minden and Lindsay districts. Small numbers of egg-masses which may result in light defoliation were found at numerous locations in southern Ontario as well as at Killarney Provincial Park, Sudbury District, on the east end of Manitoulin Island, Espanola District, and near Bass Lake and in the city of Sault Ste. Marie, Sault Ste. Marie District.

British Columbia

About 7600 sticky traps were monitored throughout British Columbia in the fourteenth year of a cooperative program with Agriculture Canada (Plant Health), FIDS, and the B.C. Forest Service. Only 26 adult male gypsy moths were trapped this year in British Columbia in 26 pheromone-baited sticky traps in 11 areas. This compared with only 12 moths in 12 traps in seven areas in 1988. Male moths were caught near Parksville (8) and Kelowna (1) for the third consecutive year, and in West Vancouver (5) for the second year. New catches were made at Quesnel (1), Manning Park (1), near Chilliwack (1), Fort Langley (1), Cultus Lake (1), CFB Jericho in Vancouver (1), on the Saanich Peninsula (5), and near Thetis Lake near Victoria (1). One new egg mass and two female moths were found at Parksville. The captures at Manning and Cypress provincial parks were in two of 278 traps set out by FIDS in 236 forested recreation areas in national and provincial parks, commercial campgrounds, or near military bases.

Following successful controls with *B.t.* in 1988 at Kelowna, Colwood, and Parksville, there were no follow-up applications in 1989.

Forest tent caterpillar
Malacosoma disstria Hbn.

The forest tent caterpillar again caused moderate to severe defoliation in trembling aspen (Figure 6). Other hosts were also affected. Although outbreaks of this insect can look spec-

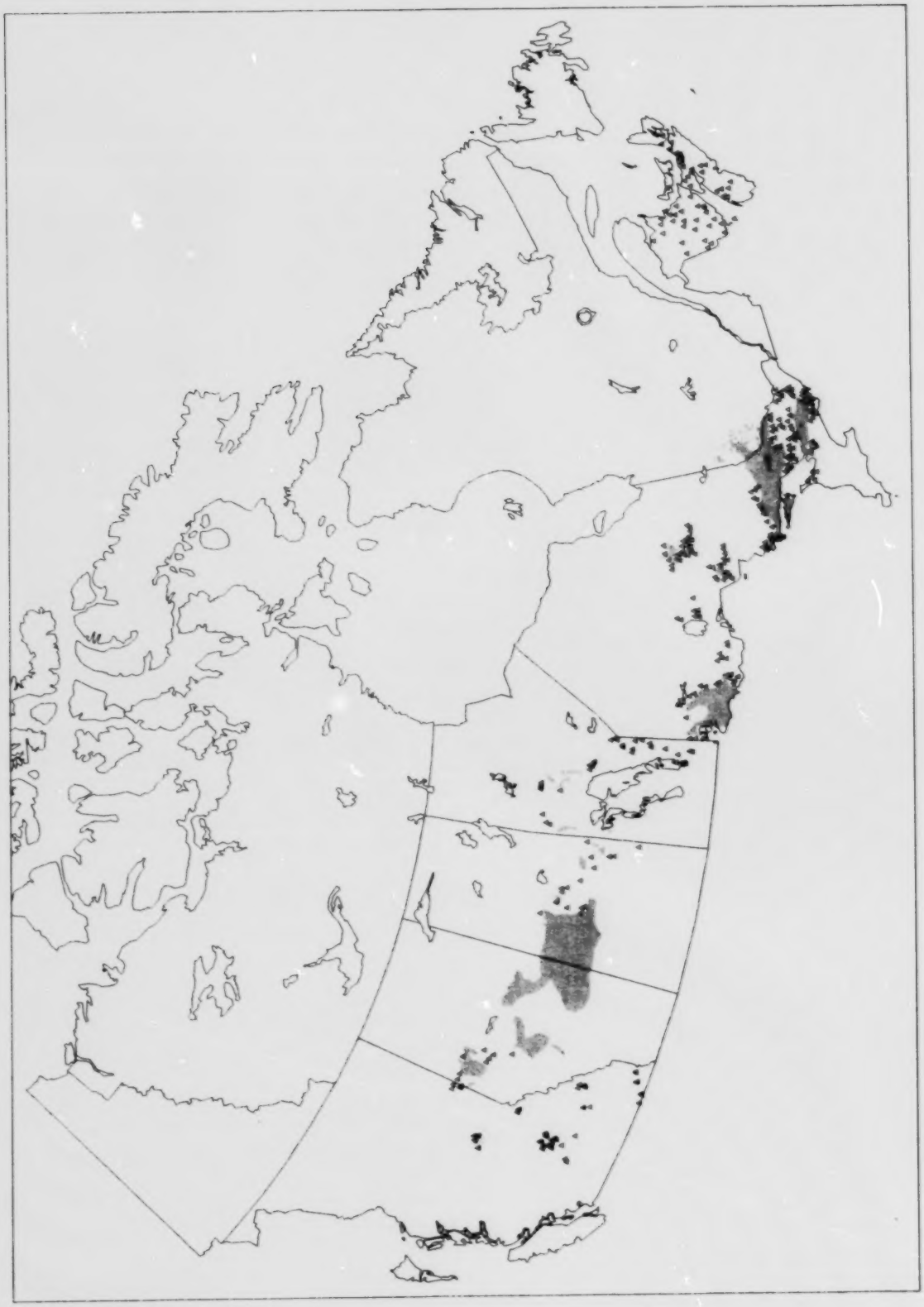

Figure 6. Forest tent caterpillar occurrence in Canada, 1989.

tacular, there have been few reports of appreciable tree mortality. The main effect of outbreaks has been reduction in the annual growth of severely defoliated trees. As the utilization and management of aspen intensifies, the impact of aspen defoliators will become more significant.

Newfoundland

Pheromone traps were placed across the Island in camping areas and near towns to collect moths that might be introduced on recreation vehicles from the mainland. No male moths were caught in these traps.

Maritime Provinces

Populations were very low throughout the Maritime Provinces as indicated by light trap catches and pheromone surveys.

Québec

Forest tent caterpillar populations in Abitibi-Témiscamingue continued to decline in 1989.

The area infested since 1985 is becoming increasingly broken up and defoliation ranges from light to moderate. However, damage has increased substantially in the Trois-Rivières and Québec City (Clermont) regions. Many small pockets of defoliation were observed around Lac Saint-Jean this year.

In Québec, close to 850 000 ha of forest were defoliated by forest tent caterpillar. Trembling aspen is the preferred host of this insect. The regions affected are Saguenay - Lac-Saint-Jean, Trois-Rivières, Montréal, Outaouais, and Abitibi-Témiscamingue.

Close to 784 000 hectares were defoliated in the Abitibi-Temiscamingue region and westernmost part of the Outaouais Region in 1989. The perimeter of the infestation is more or less the same as last year. Lac Simard and the municipality of Laniel constitute the northern and western limits of the main pocket. To the east, pockets of defoliation gradually disappear at a distance of no more than 25 km from the Dumoine River, at the longitude of Deep River, Ontario. To the southeast of this quadrilateral, between Rapides-des-Joachims and Deep River, defoliation caused by forest tent caterpillar merges with that caused by gypsy moths. In this vast area, there are scattered pockets of light (380 000 ha) and moderate (200 000 ha) defoliation. Only 14 700 ha were severely defoliated in this area. North of Lac Simard, two residual pockets persist. The first, between Rouyn and Rollet, is recurrent and defoliation is severe (7700 ha) and moderate (29 700 ha). The second, located northeast of Lac Simard, consists of light (29 900 ha) and moderate (2500 ha) defoliation. Trembling aspen is the main species affected. The maple stands south of Temiscamingue suffered only very light defoliation this year.

South of the Outaouais region, near Bristol-les-Mines, forest tent caterpillars occur together with gypsy moths. These two insects defoliated close to 2000 ha of forest in this sector. In the Montréal region, there are many small pockets of moderate and severe defoliation scattered on the North Shore of the St. Lawrence. In all cases, the areas of defoliation are small (100 to 250 ha) but damage is moderate to severe. A bit further east, in the management unit of L'Assomption-Matawin, between Saint-Côme and Saint-Barthélemy, there are larger areas of defoliation. The largest is approximately 4500 ha and is located west of Saint-Barthélemy. The loss of foliage has been estimated to be moderate over 75% of this area. The forest tent caterpillar has defoliated some stands near the municipalities of Saint-Louis-de-Terrebonne and Rawdon. In this area, trembling aspen, and occasionally, sugar maple, are its main hosts.

In the Trois-Rivières region, the area of La Tuque was highly infested. The infestation is localized along the Saint-Maurice River. Areas of moderate and severe defoliation over 11 900 and 15 500 ha respectively (total defoliated area: 30 310 ha) in a corridor ranging from 2 to 12 km in width. Further south, roughly 10 km southeast of Grand-Mère, 1720 ha of forest have been defoliated, more than 900 ha severely. South of the St. Lawrence River, many pockets of moderate defoliation have been observed between Gentilly, Daveluyville, and Sainte-Françoise, where 2000 ha have been affected, 1650 ha moderately.

Further east, the forest tent caterpillar was observed on both shores of the St. Lawrence River as far east as Rimouski on the south shore and Clermont on the north shore. In these areas, several continuous hectares have been defoliated

in some places. However, most often observed was the presence of several colonies of insects on a restricted number of trees. The insect was observed very sporadically further east, at Caplan, to the south of Sainte-Anne-des-Monte in the Gaspé and at Lac des Perches on the North Shore.

In the Saguenay - Lac Saint-Jean Region, the forest tent caterpillar, together with the large aspen tortrix *Choristoneura conflictana* (Wlk.), defoliated trembling aspen. In the north, from Saint-Félicien to Péribonka, areas of particularly severe defoliation were observed, but these were scattered in small pockets. In this area, more than 16 880 ha have been defoliated, 7660 ha severely. To the south and east of Lac Saint-Jean, from Chambord to Sainte-Monique and along the Saguenay River to Chicoutimi, the forest tent caterpillar has defoliated several small pockets, none of which exceed 350 ha in area. Foliage loss varied from light to severe and pockets of defoliation are scattered throughout the area. Damage caused by the large aspen tortrix was also occasionally observed in this sector.

Ontario

Defoliation - Province-wide aerial and ground surveys revealed 7 915 111 ha of moderate to severe defoliation, up from 3 965 229 ha in 1988. Infestations were recorded in the northwestern, central, and southern sections of the province. The largest infestation occurred in central Ontario, stretching from the Sault Ste. Marie area on Lake Superior to the Burnaby Township-Deep River area on the Ottawa River, covering some 3 460 690 ha. This encompassed large areas in the Pembroke, Algonquin Park, Bracebridge, Parry Sound, North Bay, Temagami, Sudbury, Espanola, Blind River, and Sault Ste. Marie districts including large parts of Manitoulin Island.

The second largest infestation occurred in northwestern Ontario where moderate to severe defoliation was mapped over an area of 2 554 424 ha in the Kenora, Dryden, Fort Frances, and Ignace districts. In the Thunder Bay District, 10 scattered pockets of infestation were mapped, ranging from a few to 8956 ha in size. The area affected in this part of the province was nearly 10 times that recorded in 1988.

In southern Ontario, approximately 1 945 500 ha of moderate to severe defoliation were recorded from the vicinity of Awenda Provincial Park on Georgian Bay in Huronia District east to the northern parts of Lindsay and Napanee districts. The infestation also covered parts of the Minden, Bracebridge, Bancroft, and Tweed districts.

In addition to the major infestations described above, a number of sizeable but more discrete pockets of infestation were recorded in the Owen Sound, Wawa, Terrace Bay, Cochrane, and Kapuskasing districts.

Monitoring - Egg-band counts were carried out during late August and September to determine populations and defoliation trends. In general, an increase in the area of defoliation was expected in 1990, particularly in northwestern Ontario.

Prairie Provinces

The forest tent caterpillar continued to be one of the major defoliators of trembling aspen in the Northwest Region in 1989. In Manitoba, a marked increase was reported in most of the previously reported infestation areas, as had been predicted (Figure 6). No aspen defoliation was reported in the Northwest Territories. The total estimated area of aspen forests defoliated within the region was 2 295 585 ha as compared to 3 750 876 ha in 1988.

In Manitoba, a marked increase in total area of trembling aspen defoliation was reported in 1989; 325 045 ha of aspen forests was affected compared to 52 836 ha in 1988. Infestations increased in most forest sections where they were reported last year, and some expansion into new areas. Most of the moderately to severely defoliated stands occurred in the north-central and western parts of the province in the following forest sections: Nelson River, Mountain, Highrock, Interlake, and Saskatchewan River. Smaller pockets of similar defoliation were evident in the Hayes River, Lake Winnipeg East, Aspen Parkland, and Pineland forest sections. Much of the aspen defoliation in west-central Manitoba (an estimated 18 650 ha) was caused by the large aspen tortrix (*Choristoneura conflictana*), especially in Riding Mountain National Park and Duck Mountain Provincial Park.

Egg-band surveys were carried out in the three prairie provinces in the fall of 1989 to predict defoliation levels in 1990. The results suggested some declines in population levels would occur, especially in central Alberta, west-central Saskatchewan, and much of the northern range of the outbreak area in Manitoba.

In Saskatchewan, although a decline in forest tent caterpillar population levels and defoliated areas occurred in some parts of the province in 1989, the total area of aspen defoliated (790 740 ha) remained similar to that in 1988 (932 040 ha). The main infestations occurred in the agricultural zone, with some extensions into the forested zone. In the main outbreak area in west-central Saskatchewan, moderate to severe defoliation was evident in Meadow Lake Provincial Park, south along the Alberta border to Manitou Lake, and eastward to Ruddell, Blaine Lake, Big River, Prince Albert, and Doré Lake. In the east-central part of the province, small, scattered infestations of moderate to severe defoliation were detected in the Thunder Hills, Smeaton, Nipawin, and Tobin Lake areas. Similar defoliation was present along the Carrot River west of the Manitoba border and in Duck Mountain Provincial Park. Much of the defoliation in the latter area was contributed by the large aspen tortrix.

In Alberta, the estimated area of aspen forests moderately to severely defoliated in 1989, mainly by forest tent caterpillar, was 1 179 800 ha, compared to 2 766 000 ha in 1988, a significant decrease. Other areas outside of those severely defoliated had scattered patches of light to severe defoliation, indicating a declining trend in the overall outbreak. The main infestation continued in the aspen parkland and agricultural zone in central Alberta, with considerable extension into forested areas between Edmonton and Edson, from Whitecourt to Fox Creek, between Lesser Slave Lake and Lac la Biche, and into the northern Grande Prairie Forest District. Within the general outbreak area there was a notable decline, centred on Edmonton, in areas severely defoliated, compared to last year; infestations were in scattered patches with light to severe defoliation. Moderate to severe defoliation of mixed aspen forests was extensive in the Grande Prairie-Peace River area in northwestern Alberta. Light to moderate defoliation was also present in the area north of Waterton Lakes National Park through to Twin Butte and near Mountain View. The infestation in Waterton Lakes National Park collapsed in 1989.

Aerial and ground spray control programs against the forest tent caterpillar, using mainly *B.t.*, were undertaken in several counties and provincial parks in central Alberta to reduce foliage loss and the nuisance aspect of the caterpillars.

British Columbia

Defoliation of trees and shrubs by forest tent caterpillar totalling more than 122 500 ha was more widespread and severe than in 1988 in parts of the Cariboo and Prince George forest regions, and in the East Kootenay. Although defoliation was mostly light, colonies of northern tent caterpillar *M. californicum pluviale* (Dyar) were common in the Kamloops and Prince Rupert regions, near Bella Coola, and in the East Kootenay.

In Prince George and to the northwest, forest tent caterpillar populations increased and defoliated trembling aspen and, to a lesser extent, other deciduous trees in 187 infestations over 103 225 ha. This was more than double the area affected in 1988 and in some areas the infestations continued for the fourth consecutive year. In the Peace River area, defoliation occurred over 4800 ha in 22 separate areas, similar to 1988. In the Cariboo Region, defoliation was mostly east of 100 Mile House in 26 pockets over 3215 ha, an eight-fold increase from 1988. In the Nelson Region, the area of defoliation increased fourfold to 9970 ha in 61 pockets extending from the international border in the East Kootenay north to Golden. New infestations in the Kamloops Region covered 1000 ha in seven areas mostly near Clearwater, and to a lesser extent east of Kamloops and in the north Okanagan Valley.

Northern tent caterpillar populations in previously defoliated patches of trembling aspen in the central Okanagan Valley in the Kamloops Region declined, but increased in the northern part of the valley and in the North Thompson River Valley. Alder, birch, and other trees and shrubs in the Bella Coola Valley in the Vancouver Region were lightly defoliated following two years of severe defoliation mostly near Hagensborg. The numbers of colonies in the West Kootenay declined, but were again common in the East Kootenay. Populations increased for the first time in many

years in the western part of the Prince Rupert Region, where defoliation of mostly black cottonwood was common in the Skeena River Valley, near Kitimat and west of Terrace.

Hemlock looper
Lambdina fiscellaria fiscellaria (Gn.)

The hemlock looper occurs from Newfoundland to Alberta, mainly on balsam fir. During an outbreak, however, it will feed on many conifer species and even some hardwoods. Although all eastern provinces have periodic outbreaks, Newfoundland has had regular epidemics.

Newfoundland

Defoliation - The general decline of looper populations forecast from fall egg sampling occurred in much of the area infested in 1988. However, moderate and severe defoliation continued on the Northern Peninsula and the Avalon Peninsula in 1989. The infestation continued in three separate areas on the Northern Peninsula near Ten Mile Lake, along Main Brook and near Roddickton. In addition, looper populations were interspersed with blackheaded budworm *Acleris variana* (Fern.) populations in the Castor River and Leg Pond area. In addition, six new but small infestations developed on the Island, four at separate areas along the South Coast and the others on the Avalon Peninsula, near Flatrock and Greens Harbour. Existing pockets of infestation on the Avalon Peninsula collapsed except along Shoe Cove Brook. Infestations on the Island totalled about 9500 ha of moderate and severe defoliation and 3900 ha of light defoliation (Figure 7). High numbers of looper moths were reported in the Argentia-Placentia area in September, but a local infestation did not ensue. Aspects of the reproductive biology were studied in the infestation near Flatrock to devise a moth trapping system to forecast impending looper infestations.

Damage - Most new tree mortality occurred near Leg Pond, where looper populations were the highest and where feeding was in conjunction with the blackheaded budworm. Generally, the intensity of defoliation was not as severe as several years ago, and little new mortality is expected. The damage will be assessed at the inventory level by the Newfoundland Department of Forestry and Agriculture.

Figure 7. Areas of moderate to severe defoliation by the hemlock looper in Newfoundland, 1989.

Control - The Provincial Department of Forestry and Agriculture treated about 5400 ha of infestation with *B.t.* on the Northern Peninsula.

Biological mortality factors - In 1989 hemlock looper larvae and pupae were sampled at two locations. Pupae were also sampled at one additional site on the Avalon Peninsula. Of the 780 larvae reared 3% were parasitized by ichneumonid parasites, 2% were killed by fungi, 11% contained *Aureobasidium pullulans*, less than 1% were infected with a microsporidian tentatively identified as *Pleistiphora schubergi*, and 3% died of unknown causes for a total larval mortality of 20%. Approximately 4200 pupae were collected on the Northern Peninsula of which 4% were parasitized by tachinids. Of 1100 pupae collected on the Avalon Peninsula 35% were parasitized by tachinids.

Monitoring - Overwintering eggs on branches were sampled in October at 195 locations on the Northern and Avalon Peninsulas. Looper eggs were also obtained from 135 samples collected to forecast blackheaded budworm defoliation in areas where the infestations overlap.

Maritime Provinces

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978 when the insect killed 80% of the merchantable balsam fir and over 90% of the hemlock in the affected area. In 1988, populations of hemlock looper were low throughout the Maritimes. Only one larva was collected in New Brunswick. In Nova Scotia only trace defoliation occurred in Cumberland County, while light defoliation occurred in Kings County, Prince Edward Island. Light trap catches were somewhat higher than in 1987 in southern New Brunswick and in the two National Parks in Nova Scotia.

In 1989, in New Brunswick, severe and moderate defoliation of balsam fir occurred as a result of a serious infestation of hemlock looper in the Christmas Mountain area of northwestern Northumberland County. The infestation covered the area from Logan Lake southward to Little South Branch Nepisiquit River, a distance of 20 km, and was about 4 km wide at its widest point. Joint surveys between the Forest Insect and Disease Survey and the provincial Department of Natural Resources established that the total area of defoliation was 3800 ha, of which 150 ha was severe, 2200 ha moderate, and the remaining 1450 ha light and trace defoliation. This is the first serious outbreak in the Maritimes since 1977-1978 when the insect killed large numbers of trees in Prince Edward Island. There has never been a recorded hemlock looper outbreak in New Brunswick since the establishment of the Forest Insect and Disease Survey in 1936. Insect survival was good in this area, as indicated by the large numbers of moths in the early fall, and the infestation is expected to continue in 1990. Populations may also increase in other areas of New Brunswick. Larvae were collected in York, Queens, Westmorland, and Albert counties; almost 24% of the 509 gypsy moth traps in forested areas of western Charlotte County captured hemlock looper moths (0.53 moths/trap); 17 hemlock looper moths were found in three spruce budworm pheromone traps along the Mountain Road, York County; and, hemlock looper catches were higher than last year in all six light traps, the increases more pronounced in the southern half of the Province. The most dramatic increase in a light trap was recorded at Mayfield, Charlotte County, where 611 moths were caught, compared to the 66 moths in 1988 and 7 in 1987.

In Nova Scotia, trace defoliation was observed on a few trees at Diligent River, Cumberland County, in the area where defoliation of balsam fir was moderate and severe in 1987 and where a small outbreak persisted since 1985. A few larvae were collected elsewhere in the province and 20 moths were captured in six spruce budworm pheromone traps at two locations on Cape Breton Island and a significant increase was noted in the light trap catches on Cape Breton Island and in Kejimkujik National Park.

In Prince Edward Island, moderate and light defoliation of larch occurred in the Camp Tamawaby Demonstration Woodlot in Prince County, and larvae were found but no defoliation occurred on balsam fir in the same area. A moth flight was observed in this area on August 23, indicating good survival and the possibility of defoliation in the future. The insect was also found in two other areas of Prince County, on balsam fir at Greenmount and on white spruce in the Foxley River Demonstration Woodlot. Light

trap catches were higher in Prince County than in 1988 but still lower than 1987.

Dutch elm disease
Ceratocystis ulmi (Buism.) C. Moreau

Dutch elm disease is caused by the fungus *Ceratocystis ulmi* which is transmitted chiefly by elm bark beetles. It was accidentally introduced into Canada and, since its discovery in Québec, has spread over an area stretching from southern Manitoba to the Atlantic Ocean, excluding Newfoundland. All native species of elm are susceptible, including white, red, and rock elms. The disease has caused extensive mortality in eastern North America and will probably become a serious problem in all areas where elms are grown. Few, if any, pests have had as great an impact on shade tree populations in urban areas as had Dutch elm disease. Elms are also valuable timber producing species in some areas and there the disease has had an important effect on the local economy.

Maritime Provinces

Dutch elm disease was of major concern in all three Maritime provinces in 1989.

In New Brunswick, the disease is present wherever elm trees are found. The resurgence of infection, commencing in 1984, continued, especially along river valleys. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the Province in 1989.

In Nova Scotia, the intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued within outbreak areas where sanitation was not practised, notably in Annapolis, Kings, Hants, Colchester, and Antigonish counties. There was only a marginal extension in the known distribution of the disease in 1989, with the discovery of two infected trees at Black Avon, Antigonish County.

In Prince Edward Island, the disease was first discovered in 1979 in a small area of north-central Prince County. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, none were found in 1983 and 1984, one tree was found in 1985 and two trees in 1986. In 1987, infected trees were found at eight locations at widely separated areas of western Prince County. Although the incidence of infection was generally low, the spread of the disease in this part of the Province was of concern. In 1988, the discovery of a newly infected mature elm tree at Alberry Plains, Queens County extended the distribution of Dutch elm disease eastward by approximately 90 km. The infected tree was promptly removed by the owner to minimize the danger of creating a new infection centre in the eastern part of Prince Edward Island. In 1989, there were no diseased trees in this area and infection occurred only in Prince County within the known distribution of the disease, at O'Leary and at Trout River.

In Fredericton, the progress of Dutch elm disease and the effects of the control program have been monitored since 1961, when the disease was first found in the city. The 22 trees killed by the disease in 1989 represented 0.7% of the current elm population within the Dutch Elm Disease Management Area and the lowest annual loss since 1972. The trend of decreasing losses has continued since 1980 when the loss rate peaked at 7.8% after a steady climb during the 1970s.

Cumulative loss to date amounts to 29.7% of the original urban elm stand. Loss figures may be inflated, even at these low levels, as some of the 22 trees lost were low quality, small, hedgerow trees, unlikely to have been part of the 1961 tree count, but they were still used in calculations as part of the loss from the original population figure.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1989 for elm bark beetles, the carriers of Dutch elm disease, except in Fredericton, where populations of the native elm bark beetle *Hylurgopinus rufipes* (Eichh.) remained low. The European elm bark beetle *Scolytus multistriatus* (Marsh.), the most important vector in the spread of Dutch elm disease in the United States was not captured in

1989. Single adults were captured in pheromone traps in 1982 just south of the city and in 1983 at Tay Creek, some 30 km to the north. In 1986 and 1987, single adults were captured in Fredericton on sticky band monitoring traps.

Québec

(See Table of Other Insects, Diseases, and Damage)

Ontario

(See Table of Other Insects, Diseases, and Damage)

Prairie Provinces

In Manitoba, Dutch elm disease (DED) surveys were conducted primarily by the Manitoba Department of Natural Resources in 1989. Infections continued to increase in native elm stands along some of southern Manitoba's river systems, especially the Seine, Red, and Assiniboine. Smaller rivers and creeks also had infected elms. Along the Souris River in southwestern Manitoba, the numbers of infected elms increased and the disease has since spread southward into North Dakota. Diseased elm trees in native stands are generally ignored due to the impracticality and high cost of controlling infections in these areas. Dutch elm disease infected trees were detected in the following urban centers: Winnipeg, Brandon, Portage la Prairie, Morden, Dauphin, Selkirk, Steinbach, and Winkler. Many smaller eastern and central Manitoba communities experienced an increase in diseased trees in 1989. Along the Assiniboine River near St. Lazare, diseased trees were detected approximately 4 km north of those reported in 1988. During the 1989 summer surveys, approximately 12 000 elm trees were examined in and around urban and rural municipalities. Of these, 822 trees were confirmed with DED and 11 200 were classified as hazards; many of these had died as a result of the disease. In the cities of Winnipeg and Brandon, less than 2% of the elms were infected. A total of 10 868 elm trees are scheduled for removal in the city of Winnipeg alone. The increased levels of infected elms noted in southern Manitoba in 1989 are believed to have resulted from increased stress on the trees due to severe drought conditions in 1987 and 1988.

In Riding Mountain National Park, DED was responsible for some mortality in native elm stands along the eastern escarpment of the park.

In Saskatchewan, ground surveys were conducted for the incidence of the disease and its bark beetle vectors by Saskatchewan Department of Parks, Recreation, and Culture with continuing cooperation from Agriculture Canada's Prairie Farm Rehabilitation Administration (PFRA), urban and provincial city governments, and two parks departments. Endemic populations of the native elm bark beetle *Hylurgopinus rufipes* Eichh. have been identified in native elm stands at several locations in the province. Three adults of the smaller European elm bark beetle *Scolytus multistriatus* Marsh. were found in pheromone baited traps in Regina in 1989, but no infected elm trees were evident.

Detection surveys for incidence of the disease were conducted in southern Alberta by Alberta Agriculture personnel from the Alberta Special Crops and Horticultural Research Centre in Brooks. Pheromone-baited traps and elm trap logs were set out at 27 locations and monitored monthly. No evidence of DED or its insect vectors was found in 1989.

Scleroderris canker
Gremmeniella abietina (Lagerb.) Morelet
(*Ascocalyx abietina* (Lagerb.) Schläpfer-Bernhard)

Scleroderris canker has been detected throughout Canada except in Prince Edward Island, Manitoba, and Saskatchewan. This disease of conifers is caused by the fungus *Gremmeniella abietina*, of which at least two races (North American and European) have been serologically determined.

North American race

The North American race of *G. abietina* is widely distributed in Canada and has been a serious problem in nurseries and young plantations for years. Extensive studies of the disease have provided several control recommendations. In eastern Canada the disease is most damaging to pines, especially red, jack, and Scots pines, and often kills them during their first decade of growth. However, once the trees are about 2 m high, they are relatively safe from lethal attack. In western Canada, where lodgepole, ponderosa, and whitebark pines are the principal hosts, the disease has occurred at only a few scattered locations in Alberta and British Columbia. No significant damage has been attributed to this disease in either province.

Maritime Provinces

In 1989, several jack pine and red pine plantations were found infected in the Deersdale area of Carleton County, New Brunswick damage to lower branches being extensive in some of these. The disease was also present in several Scots pine plantations near Bourgoin, Madawaska County, New Brunswick in the vicinity of the plantation from where in 1988 a sample was identified as the European race. All cultures tested in 1989 at Forestry Canada-Québec Region were of the North American race.

In order to determine whether the European race of scleroderris canker found at Bourgoin in 1988 could have originated in infected nursery stock, the New Brunswick Department of Natural Resources inspected 20 Scots pine Christmas tree plantations in Madawaska, Victoria, Carlton, York, Charlotte, and Kings counties, established with seedlings from the same nursery in 1976, 1977, and 1978. In addition, 14 red pine plantations, established with seedlings from the same nursery during the same time period, were also examined in those counties. The only infected plantation found was in Madawaska County, at Baker Brook, but the fungus was identified as the North American race.

In Nova Scotia, red pine, Scots pine, white pine, and lodgepole pine plantations, which were infected in the early to mid-1970s were re-examined in Cumberland, Halifax, Pictou, and Guysborough counties in 1989. No evidence of scleroderris canker was found in any of the plantations.

Ontario

The North American race was reported at several widely separated locations in northern Ontario. The highest incidence was in Houghton Township, Blind River District, where 78% of the trees in a 10-ha jack pine plantation were infested, up from 67% in 1988. Sixty-nine percent of the trees were infected in an 80-ha plantation of 2-m jack pine in Strey Township, Terrace Bay District, and 13% of 0.8-m red pine were infected in a 10-ha plantation in Olrig Township, North Bay District with accompanying mortality of 1.3%. Light infections with incidence ranging from 1 to 8% were recorded in a number of other areas in Geraldton, Nipigon, Espanola, and Sioux Lookout districts.

European race

In 1975 a disease syndrome different and more serious than that normally associated with scleroderris canker in North America was reported in New York State. The disease was killing large pine trees and was serologically identified as the European race of *G. abietina*. It has since been detected at scattered locations in Newfoundland, New Brunswick, Québec, and Ontario. Except in Newfoundland, the symptoms and damage caused by the European race have been indistinguishable from those of the North American race.

Newfoundland

Scleroderris canker was recorded on Austrian pines in two new locations in St. John's in 1989. Trees at both locations were pruned and the branches destroyed. Evidence of infection in St. John's persisted in 1989 but with a noticeable decrease in incidence.

A total of 16 Scots pine plantations established from stock from the Salmonier Line in the early 1950s were surveyed in 1989. Only two plantations along the Salmonier Line and Colliers Ridge on the Avalon Peninsula were infected. Medium to high levels of crown mortality and stem cankers were recorded at both locations. Cumulative tree mortality at Salmonier Line was 30%, but no tree

mortality has occurred at Colliers Ridge. Inspection of the infected Sitka spruce plantation at Roddicton revealed no sign of new or spreading canker infection.

Maritime Provinces

The European race, and several "intermediate" races, have been found in New Brunswick at 11 locations since 1978, but none later than 1981. The disease had been eradicated at three of the 11 locations even before the final race identifications were available. "Controlled" status has been achieved by the pruning of branches to 2 m from the ground at two locations, one in 1985 and one in 1987. In 1988, two more plantations in north-eastern New Brunswick were brought under "control" by pruning, the work being done by the Department of Natural Resources. The remaining four locations are "under surveillance", in that an annual inspection is conducted for symptoms and changes in symptom expression. The European race of the fungus has not been found at any of these locations since 1981.

The European race of *G. abietina* was identified at Bourgoin, Madawaska County, in 1988 in a Scots pine Christmas tree plantation. In 1989, additional sampling was conducted in this plantation and in plantations in the vicinity. Only the North American race of the fungus was found.

Québec

In 1989, 179 plantations were visited as part of the scleroderis canker detection program, 164 of which were located in the Québec City region. The remaining 15 were located in the Trois-Rivières region.

The scleroderris canker was detected in 86 plantations (Table 4). Forestry Canada-Québec Region detected the European race in 22 host plantations (16 red pine and six Scots pine) and the two races in one other plantation of the same two species. In 24 host plantations, the race of the pathogen could not be determined due to a lack of viable samples.

Quantitative evaluations conducted in the 86 host plantations revealed that more than 25% of the trees were affected in 11 of the plantations, and that from 6 to 25% of the trees were affected in 20 plantations. The plantations in which the European race was detected (23) and those in which more than 6% of the trees were affected by the American race will be the subject of an action plan in 1990.

In nurseries, *Gremmeniella abietina* was found in the spring in five plots of containerized jack pine and red pine seedlings and in a plot of bare-root red pine seedlings. Only two plots of containerized red pine had to be destroyed. In the other cases, the seedlings were sorted and an application of fungicide recommended, followed by reinspection. The plots which were free of the pathogen were replanted as planned. The race of these isolates was not determined.

Ontario

The annual aerial and ground survey program for this pathogen resulted in collections of the European race from three red pine plantations in

Table 4. Incidence of infection by scleroderris canker by species and race of pathogen in Québec

	Species							
	RPi		SPi		JPi		Total	
Healthy	44[a]	(25)[b]	11	(6)	38	(21)	93	(52)
Race								
European	16	(9)	6	(3)	-		22	(12)
American	7	(4)	4	(2)	27	(15)	38	(21)
European and American	1	(<1)	1	(<1)	-		2	(1)
Undetermined	22	(12)	-		2	(1)	24	(13)
Total	90	(51)	22	(12)	67	(37)	179	(100)

[a]Number of plantations.

[b]Percentage rounded off.

Parry Sound District with a previous history of the disease. It was also re-collected in a small red pine plantation in Mayo Township, Bancroft District, where 8% of the trees were infected. A new infection center was confirmed in Strong Township, Bracebridge District, where 16% of the 1.4-m red pine displayed symptoms of the disease. This represents a new occurrence of the European race but the location is fairly close to previous infection centres and does not indicate a significant range extension.

European larch canker
Lachnellula willkommii (Hartig) Dennis

Maritime Provinces

European larch canker, caused by the fungus *Lachnellula willkommii* (Hartig) Dennis, has been a serious disease in many parts of Europe. The fungus is considered to be a primary pathogen capable of infecting vigorous, healthy trees and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts appeared to have been successful as the disease was not found during surveys of the area in 1965. However, it was re-discovered in northeastern Maine in 1981.

In Canada, the European larch canker was first discovered in the Maritimes in 1980. Surveys since then established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. As a result, the Plant Health Division of Agriculture Canada imposed, in 1986, a quarantine directive restricting the movement of larch material from a quarantine zone which encompasses the southern and southeastern parts of New Brunswick, south of the St. John River, in the west and south of the Miramichi River in the east and all of mainland Nova Scotia. This quarantine zone is well in excess of the known distribution of the disease. Extensive surveys, conducted annually in all three provinces and involving over 500 locations since 1983, failed to extend the known distribution of the disease as established in 1981-82. The few minor adjustments which occurred were mostly in Nova Scotia and involved gap-filling along the peripheries.

In 1989, the disease was not found at any of the 101 locations surveyed outside the known distribution, 29 in New Brunswick, 64 in Nova Scotia, and 8 in Prince Edward Island. Of 10 locations examined within the known range in New Brunswick, the disease was found at two locations; 80% of the trees were infected at Vinegar Hill, Kings County and 72% at Lepreau Falls, St. John County. In Nova Scotia, the disease was found at three locations within the known distribution: 10% of the trees were infected at Upper Rawdon, Hants County, 7% at Chaswood, Halifax County, and 3% at West Gore, Hants County. Surveys in 1988 and 1989 included the examination of 28 plantations of eastern, European, Japanese, and Siberian larch, all of which were found free of the disease.

The fungus mostly infects young trees; therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there and the role of the disease will have to be considered in view of increased emphasis on forest renewal and larch tree improvement programs.

Investigation of several aspects of the behavior of the fungus under our climatic conditions has been initiated. Results will be reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence.

The disease is capable of intensifying rapidly in young stands. Incidence of infected trees in a research plot increased as follows, based on fall assessments: 1982 - 7%; 1983 - 19%; 1984 - 46%; 1985 - 88% and 1986 - 91% of trees affected.

Considering the high level of incidence, this study was terminated.

To test differences in susceptibility to infection, greenhouse-grown seedlings of *Larix decidua*, *L. leptolepis*, *L. europlepis*, *L. laricina*, and *L. sibirica* were successfully planted in a heavily infected area in the early summer of 1983. *Larix occidentalis* seedlings were added to the test in 1985. By the fall of 1987, 13 of the 24 living larch populations had at least one seedling infected and only *L. sibirica* and the late addition *L. occidentalis* were still disease free.

Pear Thrip
Taeniothrips inconsequens (Uzel)

Pear thrip *Taeniothrips inconsequens* (Uzel), a diminutive sucking insect, caused major concern in the early summer of 1988 when widespread severe and moderate defoliation of sugar maple occurred in much of New England, Pennsylvania, and New York. Close to 200 000 ha of defoliation was recorded in Vermont alone. Known mainly as a pest of fruit trees since its introduction to California around the turn of the century, pear thrips were first recognized as forest pests in 1979 when they caused widespread defoliation in Pennsylvania.

Maritime Provinces

In 1989, early surveys in the Maritimes failed to detect the insect. Acting on information from the Maine Forest Service that tiny larvae appear as "dandruff" on the underside of leaves of sugar maple under severe stress, the insect was found on seven sugar maple trees in five widely separated areas in York, Carleton, Madawaska, Gloucester, and Albert counties in New Brunswick. Further surveys will be necessary before a reliable statement can be made on the distribution of pear thrips in the Maritimes. However, the insect is present and, even though some host trees on which it was found in 1989 were stressed by other factors, its potential to cause damage has been demonstrated elsewhere.

Québec

In Québec, pear thrips were detected in orchards in the early 1950s, but to date their numbers have been negligible. Given the increased populations forecast for 1989 in northern Vermont, the FIDS unit at Forestry Canada-Québec Region and SPIM focused attention on detecting the insect in maple stands and determining its exact status in Québec.

During the last week of April 1989, Forestry Canada conducted preliminary sampling in 10 maple stands in southern Québec to detect the presence of pear thrips. The maple stands were located between Lake Champlain and Lake Memphrémagog, 10 km or less from the Vermont border. The sampling consisted in taking five blocks of organic soil, measuring roughly 15 x 15 x 15 cm at intervals of least 25 cm, from each maple stand. These samples were placed in individual sealed containers and placed in emergence chambers. After about two days at room temperature, the adult thrips emerged from the containers and were collected and counted. The insect was found in seven maple stands all located west of Lake Memphrémagog half way to Lake Champlain, and its population level was generally low.

The SPIM surveys were conducted in more than 150 maple stands. The insect was detected in 71 of these. The surveys revealed that pear thrips were widespread in Québec; they occurred throughout the South Shore of the St. Lawrence River as far as Saint-Pamphile (L'Islet) to the east, and between La Malbaie and Shawville on the North Shore. However, the damage caused was negligible and insignificant. For technical reasons, no survey could be conducted in Témiscamingue. The insects vast distribution in Québec suggests that it has been present in maple stands for years.

In view of the potential threat of pear thrips, they will be the subject of increased monitoring in the years ahead.

Ontario

The 1988 pear thrip epidemic in the Eastern Seaboard prompted the Ontario FIDS Unit to undertake a major survey to determine the distribution of pear thrips in sugar maple stands in the province. Rangers submitted numerous samples

of sugar maple flowers and buds to the Sault Ste. Marie lab and those containing thrips were checked by the Biosystematics Unit of Agriculture Canada in Ottawa to confirm their identify. Pear thrip was confirmed as present in samples covering virtually the entire range of sugar maple in the province. In all cases where pear thrips were found, damage to the host trees was negligible. Recent communications with the Ontario Ministry of Agriculture and Food reveal that pear thrips have been present in fruit orchards in Ontario for a number of years but they have not been considered a serious problem.

British Columbia

Nymphs and adult pear thrips were recovered from flowers and flushing buds of broadleaf maple *Acer macrophyllum* Pursh. in Greater Victoria. No damage was apparent on trees at the collection sites. Some morphological differences were evident between specimens of pear thrips from British Columbia and those from eastern Canada (R.G. Foottit, pers. comm.). Further surveys will be conducted in 1990 to determine the distribution of pear thrips and the significance of the morphological variation.

Forest Health Monitoring

Observing and reporting changes in the condition of the forest has been an integral part of the work done by the Forest Insect and Disease Survey in its more than 50 years of existence. Monitoring changes, regardless of the cause, has been explicit in its mandate and predates currently fashionable terminology. FIDS personnel are always on the lookout for unusual or unexplained forest conditions and have been reporting on these under various titles. To focus attention on FIDS forest health monitoring activities they are brought together in this chapter and those changes that are not attributable to actions of forest pests are briefly described.

Acid Rain National Early Warning System (ARNEWS)

The Acid Rain National Early Warning System (ARNEWS) was established by Forestry Canada in 1984 to monitor the condition and changes in the condition of the forest in order to detect early signs of acid rain damage.

ARNEWS consists of (1) permanent plots, where detailed measurements and observations are made at regular intervals; (2) condition appraisal points, where trees are checked for symptoms and specific measurements (such as needle retention) are made; and (3) continuous general surveillance for signs of changes in the health and condition of the forest.

Newfoundland

In Newfoundland eight permanent plots have been established and are being monitored. Presently, there is no noticeable effect of acid rain in the province's forests. FIDS has also established and maintained contact with other federal and provincial government agencies working on various aspects of acid rain.

Maritime Provinces

In the Maritimes Region, 17 permanent ARNEWS plots were established, representing important forest species and geographical areas. Fifteen of the plots were started in 1984 and two additional plots were set up in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc.

In 1989, all 17 plots were visited monthly from June to September to: (a) determine forest insect and disease conditions; (b) detect 'acid rain' symptoms (if any); (c) observe seed crop and premature fall discolouration; and, (d) collect ground vegetation samples. In August, detailed assessments of all plots were carried out following the procedures developed by the Maritimes FIDS unit for the national system (Magasi 1988).

Needle retention by conifers - In addition to the work on permanent plots, results of observations for signs of possible acid rain damage were recorded for most of the 374 locations where detailed pest condition assessments were made. Special attention was directed at the number of years of needle retention on coniferous species. It is apparent that the percentage of needles retained decreases with the age of foliage and the rate of the decrease varies among tree species and between provinces. It is important to realize that the figures represent provincial averages and, more importantly, that at least some of the loss is definitely attributable to feeding by defoliating insects. Similar information has been collected annually since 1985 in our effort to build a database which will allow analysis of possible changes.

Unexplained situations - Forest Insect and Disease Survey personnel are always on the lookout for unusual or unexplained forest conditions, some of which could conceivably be the result of acid rain damage. Unexplained forest conditions currently under observation are briefly described.

Deterioration of white birch along the Bay of Fundy - Annually recurring, early, and usually severe foliage browning and premature leaf fall

along the Bay of Fundy has resulted in serious deterioration of white birch trees. The cause of the condition, first reported in 1979, is not known, but insects and diseases have been ruled out and some type of pollution is suspected. Multidisciplinary research was initiated in 1986 to investigate possible causes, including acid rain, acid fog, and ozone.

In 1989, early foliage browning of white birch occurred again along the Bay of Fundy, both in New Brunswick and in Nova Scotia. Browning was present in essentially the same areas as in previous years but was generally only at trace or light intensity in late August. Discolouration intensified rapidly in early September, resulting in considerable foliage browning which was, however, clearly distinguishable from autumn leaf discolouration.

Tree condition has been assessed annually on permanent plots established since 1982. Summarized results from the eleven plots in New Brunswick for 1982-1989 are shown in Table 5. In 1989, one of the plots was lost to harvesting operations in the area.

Foliage browning of birch, similar to that along the Bay of Fundy, also occurred in other areas in both New Brunswick and Nova Scotia.

Groups of trees exhibited various degrees of symptom intensity, while other white birch trees in the same area remained green. Discoloured trees varied in size from small saplings to mature trees. Specific areas, away from the Bay of Fundy shore, where the condition was observed were in Charlotte, York, Sunbury, Queens, Kings, Albert, and Victoria counties in New Brunswick, and in Colchester, Antigonish, Pictou, Guysborough, Halifax, southern Cumberland, Hants, and Kings counties in Nova Scotia.

Condition of red spruce. In the southern part of New Brunswick, red spruce was found to be deteriorating in 1985 at many locations on Deer Island, Charlotte County. Although trees in many of these areas had been defoliated by the spruce budworm in the past, this did not adequately explain the conditions observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury counties in New Brunswick and in Hants, Cumberland, and Halifax counties in Nova Scotia to follow changes in the condition of trees. The plot in Halifax County was cut in the summer of 1987. Observations to date indicate an overall improvement on the plots, even though the rate of recovery appears to vary and a few trees have died in the Sunbury County plot.

Condition of white spruce at Loch Katrine, Antigonish Co., Nova Scotia. Chlorotic foliage has been observed since 1985 on white spruce trees near Loch Katrine, Antigonish County, Nova Scotia, in an uneven-aged stand of about 20 hectares. The current foliage is green, but all older needles on affected trees exhibit various levels of yellowish discolouration. Not all trees in the stand are affected, but trees from all age classes show similar symptoms. Yellowing is more prominent on the upper surface of needles than on the underside. Needle retention of older foliage is less than that normally found on unaffected trees. Some of the trees have thin crowns. The cause of this condition is unknown but no insects or diseases appear to be involved. In 1988, additional white spruce trees in the general vicinity exhibited

Table 5. Condition of white birch along the Bay of Fundy in New Brunswick on permanent plots, 1982-1989

Tree condition class	Percentage of trees in class							
	1982	1983	1984	1985	1986	1987	1988	1989
No dieback	92.9	83.7	64.0	45.3	14.5	-	-	-[a]
Twig dieback only	1.5	8.6	24.9	34.9	47.3	42.6	38.0	43
Twig and branch dieback	4.7	6.0	7.8	14.4	31.3	49.8	54.0	47
Dead	0.9	1.7	3.3	5.4	6.9	7.6	8.0	10

Notes: Each plot consisted of 50 tagged trees. There were 11 plots for the period 1982 to 1988. In 1989, there were 10 plots.
[a]One tree was classified as "no dieback."

chlorotic foliage. Neither foliage nor soil samples, collected in 1987, showed major differences between affected and non-affected areas that might have explained the chlorotic foliage. However, tree growth in the affected area was drastically reduced in 1984 and this rate was maintained until 1987. The average annual radial increment during 1984-1987 was reduced by 35% compared to growth in the preceding 10-year period.

In 1989, the condition was present again and the size of the affected area appears to be increasing. Yellowing is most pronounced at the tips of the one-year-old needles but is present on all older foliage as well.

Québec

The Acid Rain National Early Warning System consists in 1989 of 23 permanent observation sites in Québec. Its main objective is to carefully monitor changes in stand conditions, particularly their response to atmospheric pollutants. In 1989, FIDS-Laurentian Forestry Centre made two visits to each plot in Québec to collected data.

Soil and foliage samples were taken at four plots, Nos. 323, 324, 325 and 326. They are located near Armagh (Bellechasse), in Parc du Bic, Rivière Patapédia, and near Albertville (Matapédia). The samples are currently being analyzed.

In the spring of 1989, a wind storm caused considerable damage to Plot No. 311, Lake Baude (east), located in the Saint-Maurice Wildlife Reserve. Close to 70% of the trees were broken or uprooted and the plot had to be abandoned. The experimental design in place was removed from the forest in September.

Ontario

The Ontario portion of the Acid Rain National Early Warning System (ARNEWS) consists of some 27 plots located throughout the province in various acid rain deposition zones and in stands composed of the various economic tree species in the province. They are monitored each year for symptoms of acid rain damage as well as a number of other biotic and abiotic factors.

No specific symptoms of acid rain damage were observed in 1989, however, at one plot in Wishart Township, Sault Ste. Marie District, approximately 31% of the sugar maple trees displayed chlorotic (yellow-green) or yellow foliage, which may have been caused by drought conditions which have occurred in this part of the province for two consecutive summers. The spruce budworm caused varying levels of defoliation to white and black spruce in plots located in Sandle Lake, Sioux Lookout District, in Wiggins Township, Terrace Bay District, and in Fowler Township, Thunder Bay District. The forest tent caterpillar caused 70% defoliation of trembling aspen in a plot at Agnew Lake, Sudbury District, and 20% defoliation of white birch and trembling aspen in a plot in Mowat Township, Parry Sound District. Defoliation by the gypsy moth averaged 67% on various hardwood species and 100% on white oak in the plot in South Walsingham Township, Simcoe District, and pitted ambrosia beetles killed 80% of the 0.5-m sugar maple regeneration in West Wawanosh Township, Wingham District. Severe wind storms caused varying degrees of damage to trees in plots at Sandle Lake, Sioux Lookout District, and in Wiggins Township, Terrace Bay District.

Prairie Provinces

The Acid Rain National Early Warning System (ARNEWS) was established in 1984 to detect early signs of acid rain damage to forests. There were 12 permanent sampling plots established in the Northwest Region: 5 in Alberta, 3 in Saskatchewan, and 4 in Manitoba. These are part of a nationwide network of permanent plots set up to detect and monitor changes in soil, minor vegetation, and tree growth. All ARNEWS plots were examined twice in 1989, once in June and again in late August or in early September, and were monitored for insect, disease and physiological damage. All basic plot data previously were completeed and forwarded to the Petawawa National Forestry Institute for computer input and were published in a report. No injury attributable to acid rain symptoms was detected in any of the plots in 1989. The Suwannee River acid rain plot (Plot No. 804) in Manitoba was destroyed by fire in 1989.

British Columbia

Observations for acid rain symptoms, or symptoms which mimic those of acid rain, have been made in permanent sample plots across

British Columbia annually since 1984. Change in the condition of trees and ground cover at 9 of the 15 plots across British Columbia, monitored in 1989, was due mostly to natural suppression of understory trees. Tree mortality since establishment in 1984-87, included 12% of the understory Douglas-fir at a plot near Shawnigan Lake on Vancouver Island and 13% at Saltspring Island, in addition to 1% from Phellinus root rot, *Phellinus weirii* (Murr.) Gilbn. A total of 6% of the trees including western hemlock, cedar and Douglas-fir in five of seven plots on the lower mainland and 6% of the Engelmann spruce in the plot northeast of Quesnel had died, due mostly to suppression.

It is recognized that many factors including a wide range of insects and diseases as well as climatic factors such as drought and regional air pollution, contribute to forest decline. While Forestry Canada continues to monitor forest health and continues to be concerned about potential acid rain and long-range transportation of air pollutants, no direct link or scientific proof of any damage caused by acid rain in western forests has yet been established.

More than ten tree species and many species of ground cover were examined one or more times during 1989 in the Acid Rain National Early Warning System (ARNEWS) plots. Strong winds broke the stem of an alpine fir in the plot northeast of Prince George. Very light mottling of white spruce in the Prince George plot and on Engelmann spruce west of Castlegar was attributed to winter flecking. Spruce broom rust, *Chrysomyxa arctostaphyli* Diet., and Cooley spruce gall adelgid, *Adelges cooleyi* Gill., were present at low levels on spruce at Prince George and a mildly parasitic or saprophytic needle disease, *Phaeocryptopus nudus* (Peck) Petrak, was present at Castlegar. There was no evidence of change in the condition of trees or ground cover near Terrace, Penticton, Campbell River, and at two plots near Vancouver.

Because of increasing height of plot trees and difficulty in closely examining needle condition, additional branches on representative trees near the plots were tagged, photographed and foliar conditions recorded in 1989. Data recorded on one or two branches of up to ten 'off-plot' accessible trees included the number of years foliage retained on each branch, the percent needle retention, and needle health for each year.

Needles were retained from 2 to 21 years but varied by host. Alpine fir needles were retained for 4 to 21 years (average 10 years), spruce from 3 to 16 years (average 8 years), western hemlock for 2 to 11 years (average 5 years), Douglas-fir for 4 years and western red cedar for about 3 years. Usually more than 80% of the current and year-old needles were retained, declining to less than 5% after 10 years. Foliage retained for up to 5 years was generally green and healthy on most species at most plots. Discolouration, including mottling and yellowing, occurred occasionally in the third or fourth year, rarely on 2-year-old needles. These additional assessments and photographs will augment the national ARNEWS procedures to help detect any changes in foliar conditions.

Discolouration of coniferous and deciduous trees and shrubs likely caused by sulphur dioxide, was again common near Port Alice on northern Vancouver Island. A gradual decline in forest health is evident within 6 km of the pulp mill were dead tops, dead lateral branches, shortened needles, dead branch tips, and up to half the foliage on 15% (range 10 to 100%) of the trees was lost at four locations. From 50 to 100% of the foliage on alder, salmonberry, huckleberry, and salal were discoloured within 2 km of the mill. Cumulative damage in the area has resulted in dead tops on western hemlock in scattered patches over an estimated 300 ha on the east side of Neroutsos Inlet. Preliminary analysis of hemlock foliage in long-term study plots indicated higher sulphur levels in trees farther from the mill than in trees closer to the mill; the form of sulphur may be significant and further analysis is being done.

Decline, dieback, and stress-related disorders

Maple dieback and decline

Decline of sugar maple in eastern North America remains the focus of considerable research which attempts to explain the causes of

extensive widespread deterioration. Although the decline is not restricted exclusively to sugar maple, it is the most seriously affected hardwood species and there has been great concern about the effects of the decline on the maple syrup industry and other forestry-related activities. Forest declines that occur periodically and without any apparent cause have been documented throughout the history of eastern North American forests. It remains to be seen whether the current condition, with its often variable symptoms, is the result of a natural fluctuation in a dynamic ecosystem or is caused by some other, possibly human-caused phenomenon.

Maritime Provinces

In the Maritimes, although some sugar maple stands were found in deteriorating condition during surveys in 1986 and 1987, no widespread decline was evident. In 1989, suspect stands were again investigated, including an area of about 300 km^2 west of Napodogan, York County, New Brunswick, where patches of both sugar maple and red maple showed decline symptoms. Mature and semi-mature trees were the most affected, especially in areas of old cuts where red maple trees were left standing.

In Nova Scotia, significant changes in tree condition were recorded between 1988 and 1989 on four sugar maple monitoring plots established in 1982. Overall, 44% of trees showed an increase in the amount of dieback. While the levels of dieback are still not considered serious, the trend is causing concern. Monitoring will continue to determine if these trees continue to deteriorate or recover in the next few years.

Québec

Again in 1989, the Applied Research Service and the Insect and Disease Control Service of the Québec Department of Energy and Resources (SPIM) pursued activities associated with the dynamics, progression, and severity of maple decline.

The Applied Research Service focused its efforts on the dynamics and progression of forest decline by re-evaluating the 256 semi-permanent sample plots located throughout Québec's hardwood forest, from Témiscamingue in the west to Matane in the east. The methodology used to re-evaluate decline was the same as that used in 1988 and consisted of estimating the percentage of foliage missing from each tree on the sample plot. This led to a division into classes. The exercise made it possible to compare the state of decline from year to year and to trace changes that have occurred since the plots were established.

The results of the 1989 re-evaluation were quite encouraging. At each of the sample plots in Québec, the severity of the decline, or the percentage of foliage missing, decreased for the second consecutive year. After reaching a high of 28.1% in 1987, it dropped to 26.5% in 1988 and to 23.6% in 1989 (the 1986 level). With respect to incidence, or the percentage of trees affected, a high of 88.8% was reached in 1988, and it then dropped to 84.2% in 1989, about the same level as in 1987.

The greatest improvement in terms of the number of trees affected was in the central Appalachian area. There, the rate dropped from 91.8% to 83.1%. Severity declined in the Lower St. Lawrence, Montmagny-L'Islet, central Appalachian, Montréal Island, and Eastern Townships regions. Only in the Outaouais - Gatineau and Lanaudière lowlands areas was there a slight increase in maple decline. The other sectors of Québec were considered stable.

Ontario

Since 1987 the FIDS Unit has established ninety, 25-tree plots in woodlot or natural stands of sugar maple throughout its range in Ontario. In 1989 another 21 plots, each consisting of 25 rural or roadside trees, were established along with an additional 20 plots of 25 trees each in urban situations. An analysis of results showed that 84% of the 2248 natural stand trees were healthy, 14% displayed minor dieback symptoms, 1.3% exhibited moderate to severe dieback symptoms, and 0.7% were dead. This compares with figures of 88.3%, 10%, 1.5% and 0.2% in the respective categories in 1988. It is possible that the slight changes in categories may be due to severe drought conditions and heavy infestations of forest tent caterpillar which occurred within much of the range of sugar maple in 1988 and 1989. In the case of rural-roadside trees 53.7% of the 518 trees were healthy, 33.4% showed minor dieback symptoms, 12.6% showed moderate to severe dieback symptoms, and 0.3% were dead. The 490 urban trees were rated as 68.6% healthy, 25.5% with minor dieback

symptoms, 5.5% with moderate to severe dieback symptoms, and 0.4% dead.

North American Sugar Maple Decline Project (NASMDP)

This is a joint forest research and monitoring project carried out by Forestry Canada and the USDA Forest Service. It focuses on monitoring changes in maple sugar decline in the entire range of the species in eastern North America.

Maritime Provinces

Field data was collected for the second year by FIDS and the New Brunswick Departments of Environment and Natural Resources. Managed sugar bushes and undisturbed stands were assessed. In 1989, the 10 New Brunswick and two Nova Scotia plots were augmented by two additional plots to complete the pairing of sugar bush and non-sugar bush plots. Tree condition was also assessed using NASMDP methodology in two independent (that is, non-paired) areas east of St. Quentin, Restigouche County, N.B. where there is considerable interest in expanding the maple sugar industry. Trees in these areas were in better condition than the provincial average.

The NASMDP data collected during 1988 showed that 94% of sugar maple in sugar bushes and 99% of those in natural stands had no more than 10% dieback. Some dieback within a stand is considered normal, thus the amounts found on average are not significant. The percentage of trees within the 0-10% dieback class ranged from 80% to 100%. Statistical analysis showed that there were no significant differences between sugar bush and non-sugar bush stands in dieback or in two other decline symptoms, leaf density and discolouration. A more critical analysis will be possible as 'change' data becomes available from the 1989 measurements.

In Prince Edward Island, although no sites were available which met the criteria set for the NASMDP, seven independent plots were established in 1989 and trees were assessed using NASMDP methodology. An average more than 99% of the trees on these plots had 0-10% dieback, suggesting that sugar maples in PEI were in good condition.

Québec

Measurements in Québec were taken in accordance with precise NASMDP directives.

Ontario

A number of parameters relating to site and stand condition were measured, along with the current condition of each tree and insect and disease conditions in each stand. The data collected are being analyzed to determine the rate of change if any over the three-year life of the project.

Red oak decline

Ontario

Twelve plots in southern Ontario are being used to chart the long term health of red oak, with a total of 1177 trees being examined each year. In 1989, 84.5% of the trees showed either very light decline symptoms or none at all. This was slightly lower than the 88% recorded in 1988. The proportion displaying moderate to severe decline symptoms rose from 1.8% to 3.9%; 11.6% of these trees were dead.

Special Surveys

Cone and seed pests

The establishment of seed orchards created a new category of high value areas in several Regions. Seed orchards and seed production are as important to nursery programs as seedling production in nurseries is to plantation programs. Consequently, anything that interferes with seed orchards also affects most other phases of forestry operations aimed at future wood production. Forest pests in seed orchards and other seed production areas, both insects and diseases, have the potential to seriously affect seed production, either directly, by destroying seed or cones, or indirectly, by affecting the condition of trees, thus interfering with their ability to produce seed.

Maritime Provinces

The cone crop per tree in 1989 was not as heavy as in the previous year. However, there were almost as many cones collected, as more orchard trees are beginning to produce, a pattern which can be expected to continue for the next five to 10 years.

Insects - Spruce cone maggot *Strobilomyia neanthracinum* Michelsen (formerly *Hylemya anthracina* (Czerny)) damage was found again at low to moderate levels in all of the cone-bearing white spruce orchards in Nova Scotia, as well as in two orchards in New Brunswick. In one New Brunswick black spruce seedling seed orchard, 16% of cones were infested (five cones per tree from five trees collected over six dates).

Coneworms, *Dioryctria* sp., were found in cones of all four spruces and jack pine in various seed orchards in the Maritimes. Fire coneworm *Dioryctria abietivorella* (Grt.) damage was at moderate levels in two black spruce seedling orchards in New Brunswick.

Spruce cone gall midge *Dasineura canadensis* Felt and spruce cone axis midge *D. rachiphaga* Tripp were both found in one orchard each of red spruce and white spruce in Nova Scotia. The spruce cone axis midge damaged 12% of the cones (sample of 10 cones per tree from five trees) in one black spruce orchard in New Brunswick.

Spruce budworm *Choristoneura fumiferana* (Clem.) caused moderate cone losses in one black spruce seedling seed orchard in New Brunswick for the second consecutive year.

Spruce micro-moth *Endopiza piceana* (Free.) was associated with light cone damage in one white spruce orchard in Nova Scotia. Damage from the spruce bud scale *Physokermes piceae* (Schr.) was light in one white spruce orchard in New Brunswick.

A number of sawflies were found in relatively low numbers in one white pine orchard, a Japanese larch orchard, and several white spruce orchards. These included a webspinning sawfly *Cephalcia* sp. (Pamphiliidae), the white pine sawfly *Neodiprion pinetum* (Nort.), a larch sawfly *Anoplonyx* sp., and the yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.).

Light damage by the spruce budmoth *Zeiraphera canadensis* Mut. & Free. occurred in two white spruce orchards, one in New Brunswick and one in Nova Scotia, while *Zeiraphera* sp. damage also occurred in one Nova Scotia red spruce orchard.

The w-marked cutworm *Spaelotis clandestinis* (Harr.) caused moderate early season defoliation in a white spruce orchard in New Brunswick. This pest generally feeds on grass and similar vegetation and does not feed so extensively on trees, especially upper crown foliage. However, in the spring of 1989, the cover crop had not 'greened up' when these insects were active and perhaps they moved to the only available food source, the elongating white spruce shoots. An egg-mass of another cutworm *Noctua pronuba* (L.) was collected in a Norway spruce seed orchard in Nova Scotia.

Other insects causing trace or light defoliation included the larch casebearer *Coleophora laricella* (Hbn.) in a Japanese larch seed orchard, the eastern blackheaded budworm *Acleris variana* (Fern.) in one black spruce orchard, and the chamaeleon caterpillar *Anomogyna elimata* (Gn.) in a jack pine orchard.

Cones in one New Brunswick tamarack orchard were infested by a complex of four insects

including *Archips* sp., *Coleotechnites* sp., *Resseliella* sp., and *Hymenoptera*.

Aphids were found in all of the Maritime seed orchards in 1989, while mites were most prevalent in larch orchards. The species found and population levels varied considerably between orchards.

Populations of spider mites *Tetranychidae* were high in one tamarack orchard in New Brunswick, with approximately 80% of the trees being attacked. Low populations were found in two other tamarack and one red spruce orchard.

Gall adelgids, *Adelges* spp., were present in low to moderate populations in all of the tamarack orchards in the Maritimes. Aphids present in spruce orchards included *Cinara* spp., a conifer aphid, the ragged spruce gall adelgid *Pineus similis* (Gill.), the eastern spruce gall adelgid *Adelges abietis* (L.), and a single find which was tentatively identified as a twig aphid, *Mindarus* spp. Aphids present in pine orchards included *Cinara* spp. and the pine bark adelgid *Pineus strobi* (Htg.).

Diseases - The spring and early summer of 1989 was relatively cool and damp in much of Nova Scotia. While the cone and seed diseases were down considerably from 1988, sirococcus shoot blight Sirococcus conigenus (DC.) P. Cannon & Minter was present in all of the spruce orchards in the province. Damage was especially severe in one clone bank. Scleroderris canker *Gremmeniella abietina* (Lagerb.) Morelet was present in moderate to high levels for the third consecutive year in a New Brunswick jack pine seedling seed orchard despite pruning of the lower limbs in 1987. Spruce needle rust *Pucciniastrum americanum* (Farl.) Arth. was present in all white spruce orchards in the Region, although mostly at low to trace levels. Spruce cone rust *Chrysomyxa pirolata* Wint. was found only on a few spruce cones at seed orchards throughout the Region. Needle rusts on various hosts were present, but in insignificant amounts. Eastern dwarf mistletoe *Arceuthobium pusillum* Peck was found for the first time in a white spruce clonal orchard in Nova Scotia. Armillaria root rot *Armillaria mellea* (Vahl ex Fr.) Kummer continued to kill trees in black spruce seedling seed orchards planted on cutovers, one in Nova Scotia and three in New Brunswick. Globose gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka was again a problem in several jack pine seed orchards in New Brunswick. Removing galls by pruning infected limbs continues to be a routine practice in jack pine orchards.

Mammals - Mouse damage was light in 1989 largely due to the effective control programs implemented in 1988. Feeding by porcupines, snowshoe hare, and deer was minimal in 1989.

Abiotic factors - Moderate foliage burn occurred as a result of severe drought following a herbicide application in one black spruce seedling orchard in New Brunswick. The problem was most severe for trees in the drier portions of the orchard where a heavy 6 mil. black plastic was used as mulch. Trees in blocks where the soil was more moist (closer to a river) did not burn and the affected areas of the orchard were irrigated following the appearance of damage. Fertilizer burn was also a problem in a seed orchard in Annapolis County, Nova Scotia, where light to moderate foliage browning occurred on almost a third of the trees in one section.

Ontario

The cone and seed pest survey focused on white pine in southern Ontario and black spruce in northern Ontario in 1989. For the black spruce survey, each ranger collected 100 cones from an upland site, preferably a seed production area, and 100 cones from a lowland site. The cones were mature and fully developed but still green and not hardened and the samples were dissected and analyzed in the Forestry Canada Sault Ste. Marie laboratory. The methodology was similar for white pine cones in that 100 mature second-year cones were collected by each ranger, preferably from a seed orchard or seed production area. These cones were also dissected and analyzed in the Sault laboratory.

Of 1300 cones in the black spruce survey 443 or 34% were damaged by various agents. The proportion of damaged cones ranged from a low of 8% in Marson Township, Fort Frances District, to a high of 87% at a site on the Vermilion Road, Sioux Lookout District. Seed loss within damaged cones averaged 3.3% and ranged from a low of 5% in Hoey Township, Chapleau District, to a high of 72% at the Vermilion Road, Sioux Lookout District site. The principal agents causing damage and seed loss were as follows: the spruce cone axis

midge *Dasineura rachiphaga* Tripp, the spruce cone maggot *Lasiomma anthracina* (Czerny) the spruce micro-moth *Endopiza piceana* (Free.), the spruce cone rust *Chrysomyxa pirolata* Wint., unknown lepidoptera, unknown agents, and the spruce seed moth *Cydia strobilella* (L.).

A total of 600 white pine cones were dissected of which 41 were damaged, with an average seed loss within damaged cones of 375. The proportion of damaged cones ranged from a low of 19% in Kirkwood Township, Blind River District, to a high of 76% in Hungerford Township, Tweed District. The average seed loss within damaged cones ranged from 3% in Macaulay Township, Bracebridge District, to 73% in Hungerford Township, Tweed District. The principal agents causing damage were the white pine cone borer *Eucosma tocullionana* Heinr., the white pine cone beetle *Conophthorus coniperda* (Schw.), a cone midge *Resseliella* sp., unknown lepidoptera, unknown agents, and the fir coneworm *Dioryctria abietivorella* (Grt.).

British Columbia

Assessments of cone and seed insects and diseases in the Pacific Region were deemphasized in 1989. This was due in part to the conclusion of a research study at Pacific Forestry Centre and some seed orchard pest assessments done by the British Columbia Forest Service.

Twelve coastal and three interior seed orchards were surveyed in total. Cooley spruce gall adelgid *Adelges cooleyi* (Gill.) lightly infested Douglas-fir in six orchards, Sitka spruce in one, and white spruce in two interior orchards. Balsam wooly adelgid *Adelges piceae* (Ratz.) and balsam twig aphid *Mindarus abietinus* (Koch) were common on amabilis fir in four orchards; the aphid was severe on Sitka spruce at one. A gall midge, *Contarinia* n. sp., lightly infested yellow cedar at one of two seed orchards and a foliage and cone mite *Trisetacus chamaecypari* Smith was more numerous than in 1988, severely infesting all the yellow cedar at a second orchard. Hemlock woolly adelgid *Adelges tsugae* (Annand.) increased and lightly to moderately infested western hemlock at two of four orchards. In one interior orchard, western spruce budworm *Choristoneura occidentalis* Free. larvae feeding in lodgepole pine seedlings distorted lateral and terminal shoots on 5% of the trees. In another, spruce weevil *Pissodes strobi* (Peck) attacked 40% of the white spruce leaders, frost damaged 20% of the buds, and most of the lodgepole pine were lightly infected by a needle disease, *Lophodermella concolor* (Dearn.) Darker. Cone crops at 7 of 12 coastal seed orchards were affected by several pests including Douglas-fir coneworm *Dioryctria abietivorella* (Grt.) which infested up to 80% of the cones. Douglas-fir cone gall midge *Dasineura canadensis* (Felt) occurred in up to 100% (average 50%) of the cones in four orchards, and Douglas-fir cone scale midge *Contarinia washingtonensis* Johnson lightly infested cones at two orchards.

Nursery and greenhouse pests

Of the conditions encountered in 1989 in nurseries and greenhouses, some are mentioned here because of their importance, while others demonstrate that no facet of forestry is without problems. Although the insects and diseases mentioned may appear insignificant, they occurred despite constant vigilance and continuing control measures.

Maritime Provinces

Abiotic problems were widespread and severe in 1989. Considerable seedling losses occurred and many "surviving" trees were injured to some extent.

Insects - Pine bark adelgid *Pineus strobi* (Htg.) was present on three-year-old white pine bareroot stock in a New Brunswick nursery. Spruce budmoth *Zeiraphera canadensis* Mut. & Free. caused damage on two-year-old white spruce bareroot hedging material in a Nova Scotia nursery. Spruce budworm *Choristoneura fumiferana* (Clem.) was the probable cause of damage on black spruce container seedlings in a greenhouse.

Diseases - Gray mould *Botrytis cinerea* Pers. ex Fr. was very heavy on 300 000 one-year-old white spruce container stock overwintered at a Nova Scotia nursery. The mold was common throughout the Region as a secondary infection whenever nursery stock was stressed or injured by abiotic causes. Sirococcus shoot blight *Sirococcus coni-*

genus (DC) P. Cannon & Minter was found in both spring and summer greenhouse crops of white spruce container stock at a Nova Scotia nursery. Vigilance and control measures prevented serious losses. A seedborne fungus, *Fusarium* sp., capable of causing top blight and damping off, was common and caused seedling mortality in Norway spruce germinated from an imported seedlot at a Nova Scotia nursery.

Abiotic factors - Abiotic factors, singly or in combination, resulted in more seedling losses than insects and diseases combined again this year. Losses were substantial, with many millions of seedlings injured or dying.

Although not readily apparent until spring, overwintering injury was common in most nurseries in the Maritimes. Insufficient snow cover during periods of extreme cold in late fall and early winter caused widespread root mortality which was only seen after the stock broke dormancy in the nursery or in newly established plantations. Extensive overwintering root damage was present on red spruce, black spruce, and white spruce container stock at two nurseries in Nova Scotia. Similar damage was found in New Brunswick nurseries. Seedlings grown too large for the container, with poor roots as a result of excessive fertilization, are prime candidates for overwintering injury. Crops overwintered in this condition are extremely vulnerable to damage by gray mould *Botrytis cinerea* and other fungi.

Abiotic problems in 1989 also included watering problems, heat lesions, and frost damage.

Stillwell's syndrome

Stillwell's syndrome occurs when fairly well-foliaged balsam firs turn bright red and die without any seeming cause or explanation. This phenomenon is well known in balsam fir stands where considerable damage or mortality has already occurred. The rapid demise of surviving trees in spruce budworm-damaged stands during the apparent recovery stage, even years after the collapse of an outbreak, has been referred to as Stillwell's syndrome since 1982, when FIDS first drew attention to this condition.

While the exact cause of Stillwell's syndrome is unknown, it is a fact that balsam firs stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms normally considered secondary in danger, among them Armillaria root rot and several species of beetles such as balsam bark weevil, balsam fir bark beetle, and sawyer beetle.

Maritime Provinces

In 1989, the number of trees affected by this condition was generally low, although tree mortality occurred throughout New Brunswick and Nova Scotia. In the former, mortality was less than 5%, except at two locations in the southwest where 16% of the trees died at Little John River, York County and 12% died at Seven Mile Lake, Charlotte County. In Nova Scotia, dead balsam fir trees were still more prevalent in Colchester and Cumberland counties than in other areas of the province. No affected trees were observed in Prince Edward Island.

Québec

Three stands of balsam fir are being monitored for this phenomenon in the vicinity of Joliette, Lake Laflamme in the Laurentian reserve, and Trinité-des-Monts (Rimouski), and bark miner activity is prominent.

In the Lake Laflamme and Trinité-des-Monts stands, the severity of the infestation has tended to decline over the years, although the annual mortality increased somewhat in trees severely affected the previous year. These two stands were not seriously defoliated by the spruce budworm as they were in past years.

In the third stand, near Joliette, populations of wood-boring insects fluctuated considerably. We are currently unable to explain this phenomenon. This stand was severely affected by an ice storm in the fall of 1983 and has not been seriously defoliated by the budworm for several years. In addition, there are many hardwoods in the stand and the fir trees are younger on average age compared to the other two stands.

Pinewood nematode
Bursaphelenchus xylophilus (Steiner and Buhrer) Nicle

Newfoundland and Labrador

Over the period May 1988 to March 1989, 143 samples were collected from 26 sites in Labrador. Collections were made of dead, dying, and healthy balsam fir (45 samples), black spruce (69), and eastern larch (24) and dead and healthy white spruce (4). Of these, nine samples (6.3%) were associated with nematodes but *Bursaphelenchus xylophilus* was not found. Although nematodes were found in a few of the 346 insects collected in Newfoundland and Labrador in 1987-88, there were no pinewood nematodes.

Maritime Provinces

Partly in response to questions regarding the spread of pinewood nematode in 'vector-infested' lumber, a study was launched to investigate the effect of grub holes on the quality of lumber. In 1989, eight samples of spruce, fir, and pine infested by wood boring and bark inhabiting insects were tested. All were negative for the pinewood nematode.

Québec

No specific surveys were conducted for the pinewood nematode in 1989.

Ontario

In 1989, studies continued to determine the rate of spread of the nematode at known infection sites. A sampling program was also continued to try to ascertain if the "r" form of the pinewood nematode inhabits black spruce in Ontario. Results of the first program indicated that no spread of the nematode has occurred from infested trees to adjacent healthy trees at 28 known infection sites checked in 1989. In the black spruce survey, although the total number of samples was relatively small, the "r" form was not detected. The "m" form of the nematode was found in a few trees.

British Columbia

The pinewood nematode is very rare in the forests of British Columbia with only individual, predisposed trees affected at widely dispersed locations. In more than 1200 samples collected since 1982 by Forestry Canada from recently dead or dying conifers and potential vectors, the nematode of either "m" or "r" form has been recovered only from five widely scattered and previously damaged trees and from one woodborer, *Monochamus maculosus* Hald. More than 200 potential vectors including woodborers, bark beetles, wood wasps, and others were collected in the Pacific Region in 1988, and submitted to Memorial University of Newfoundland for extraction of nematodes; all were negative. Additionally, the nematode was detected at six of 10 chip piles surveyed by Agriculture Canada - Plant Protection; of these two were designated "m" form and four "r" form. More than 75 stem sections from five host species were collected from 20 locations in five forest regions in 1989 to initiate a study of the potential for various wood boring insects to be vectors for the nematode.

Pests in young stands and plantations

Newfoundland

Balsam woolly adelgid *Adelges picea* (Ratz.) - The last adelgid outbreak, from 1949 to 1967, caused considerable damage and tree mortality in fir stands throughout southwestern areas of Newfoundland. The current outbreak began in 1979 and population levels have been steadily increasing throughout the island in young stands of balsam fir where, recently, some damage has been seen. The 1988 preliminary survey of active infestations in thinned stands established baseline population data. About 90% of these damaged stands occur in western Newfoundland.

In 1989 there was an intensive survey to plot the distribution of the adelgid and its damage throughout the western and central areas of the

Island. In 1988-89 research to develop effective, practical controls have also been initiated by staff of Forestry Canada, Newfoundland and Labrador Region, in cooperation with the Forest Pest Management Institute.

Balsam fir sawfly *Neodiprion abietis* complex - Population levels were extremely high along the Lower Salmon River to St. Joseph's Cove, Bay d'Espoir and along the White Bear River on the southwest coast. Stands consisting of stunted balsam fir in the river valleys and vigorous young stands in the Bay d'Espoir area were severely damaged.

Moderate and severe defoliation occurred on 1230 ha in the Bay d'Espoir area and on 55 ha in the White Bear River infestation. Light defoliation occurred on 112 ha in the St. Joseph's Cove area.

Black army cutworm *Actebia fennica* (Tauscher) - Population levels were low in most areas surveyed throughout the Island. Several plantations were expected to have high larval numbers based on high moth counts in pheromone traps in 1988. However, the infestations were in the third year and surveys indicate that overwintering cutworm populations usually decline during the third year of infestation.

Forestry Canada, in cooperation with Memorial University of Newfoundland, tested the use of nematodes for the biological control of the cutworm near Heatherton. Unfortunately, larval population levels were too low to evaluate the use of nematodes.

Armillaria root rot *Armillaria* species - This disease caused tree mortality in a precommercial thinned fir stand in the Hawkes Bay area. The stand was severely damaged by the hemlock looper in 1988 but was recovering before the root rot attack.

Abiotic factors - Severe winter drying of pines, spruces, and fir was common in several locations throughout the Island in 1989. Light to severe reddening of foliage occurred on balsam fir and white spruce along the west coast of the Northern Peninsula. Pines were damaged throughout St. John's and in the Conception Bay area.

Severe frost injury occurred on 400 ha of balsam fir and black spruce regeneration along a road near the Gander River in central Newfoundland. Frost injury also occurred along Fischel's River, where severe damage of new growth on black spruce regeneration occurred. The foliage of several species of hardwoods was severely affected in and around the St. John's area.

Maritime Provinces

In 1989, the Forest Insect and Disease Survey, two provincial agencies, an educational institution, and seven companies assessed pest conditions on over 35 000 trees in more than 900 plantations in New Brunswick and Nova Scotia. The increasing importance of planted trees in forest management resulted in the initiation of an annual plantation assessment program in 1982.

In 1989, there were 908 plantations assessed by the various organizations, 248 in New Brunswick, 671 in Nova Scotia (57 of these by the "regular method" and 614 by the "Scott Worldwide Inc. method"), and three in Prince Edward Island. Forty of the plantations were assessed twice during the summer. The New Brunswick Department of Natural Resources also assessed 14 thinned areas.

A few brief comments on the results follow. The comments are based on plantations assessed by the "regular method" only.

1. Over 90% of the trees assessed in New Brunswick and Nova Scotia were classified as healthy.
2. Even though most trees were classified as healthy there were at least some trees with severe damage in 34% of the plantations assessed in New Brunswick and 19% in Nova Scotia.
3. There was a significant difference, on a regional basis, between spruce and pine plantations in the occurrence of severely damaged trees. While 36% of spruce plantations had at least some severely damaged trees only 16% of pine plantations were so affected.

Spruce budmoths *Zeiraphira* spp. - Spruce budmoths on white spruce comprise a group of closely related species: the spruce budmoth *Zeiraphera canadensis* Mutuura and Freeman, the purple-striped shootmoth *Zeiraphera unfortunana* Powell, and the lesser yellow shootworm *Zeiraphera fortunana* (Kft.). Usually *Z. canadensis* is the most common and most important of the three

species but occasionally the species-mix changes in favour of one of the other two budmoths.

In New Brunswick in 1989 more than 13% of white spruce shoots were damaged by budmoths, compared to 10% the previous year. Damage occurred throughout the province and was highest at St. Luc, Kent County, where 41% of the shoots were affected (compared to 49% in 1988) and 33% at Mitchell Settlement, Restigouche County. More than 20% shoot damage was recorded in several areas of Restigouche, Gloucester, Carleton, Kings, and Westmorland counties.

In Nova Scotia, an average of 11% of white spruce shoots were damaged at locations scattered throughout the Province, compared to 12% in 1988. The most serious damage occurred at South Williamston, Annapolis County, where 68% of the shoots were affected. Other areas with more than 30% shoot damage included Big Hill, Victoria County (44%), Swallow Hill, Cumberland County (41%), and Round Hill, Annapolis County (37%).

In Prince Edward Island, an average of almost 19% of white spruce shoots were damaged at the 23 locations assessed, compared to 7% in 1988 and 15% in 1987. Shoot damage was highest in Prince County where 53% of the shoots were affected at Foxley River, and 35% at East Bideford. Over 20% damage occurred at several other locations in this county, as well as in Queens and Kings counties.

In the fifth year of a developmental program towards control of the spruce budmoths, J.D. Irving Ltd., in cooperation with Forestry Canada - Maritimes Region, treated 1 800 ha of white spruce plantations with two applications of fenitrothion (Sumithion®) in northwestern New Brunswick. The chemical was applied at 105 g/ha in a total mix of 0.42 L/ha per application (an UULV formulation). Treatment was timed to coincide with adult emergence and results confirmed findings of previous years that, when applied at the proper times, enough adult moths are killed to impact on egg laying and significantly reduce damage the following year.

Sirococcus shoot blight *Sirococcus conigenus* (DC) P. Cannon & Minter - The disease is present in all three provinces but is most widely distributed in red pine plantations in Nova Scotia, west of the Colchester-Pictou and Halifax-Guysborough county lines, and in natural regeneration in the southern half of New Brunswick.

In 1989, the disease intensified in the Maritimes. In many areas, repeated infection has resulted in serious deterioration of red pine stands and plantations, in some to the extent that salvage operations had to be carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the Province, although affected plantations are known as far north as a line from southern Victoria to northern Kent counties. In 1989, the disease was found in a large red pine plantation at Little Forks, Kent County and in a natural stand near MacKenzie Brook, east of Doaktown, Northumberland County, as well as in other areas known to be infected. In both new cases, scattered "wolf" trees or overstorey trees are infected and these in turn serve as sources of infection for plantation trees or natural regeneration. The deterioration of red pine trees in the Headquarters area of Fundy National Park continues. Some trees, 10-12 m high, have died while some others have only a few tufts of green foliage left near the top.

In Nova Scotia, infected red pine plantations continued to deteriorate over much of the western part of the Province. Damage was especially serious at Debert, Colchester County, Diligent River, and within the Chignecto Game Sanctuary, Cumberland County, the Stanley Management Area, Hants County and the Kedge River Management Area, Queens County. In the eastern half of the Province the disease is spreading and intensifying in the Perch Lake area of Pictou County, where it reappeared in 1988 after an incomplete effort at control in 1986. Sirococcus shoot blight was recorded for the first time in 1989 at Eatonville, Cumberland County, where 60% of the trees were infected, at Lake George, Kings County, and in a young 20 ha red pine plantation in East Pubnico, Yarmouth County. Infected trees were observed for the first time since 1974 in the Garden of Eden Barrens, Pictou County, where light and moderate shoot damage occurred on 5-10 m high trees.

About 10% of the trees in a white spruce clone bank at Debert, Colchester County, were infected and shoot damage on affected trees averaged 52%. Infected red pine trees are present in the surrounding natural forest and the area of the clone

bank which sustained damage is located closest to this natural forest. Sanitation measures taken after the discovery of the problem included pruning of infected shoots and removal of heavily damage trees.

The deterioration of pine stands caused by this disease in western Nova Scotia and the spread of the disease to plantations in the eastern half of the Province, where red pine has been a major plantation species in recent years, makes Sirococcus shoot blight one of the major plantation problems in Nova Scotia.

In Prince Edward Island, the disease has been present at a few scattered locations and has been under observation for some years. In 1989, the disease intensified at all three locations as more shoots became infected. Sirococcus shoot blight was identified for the first time in several areas in the eastern half of the Province. Less than 5% of the trees were affected in red pine plantations at Cardigan, Heatherdale, Brudenell Point, Kings County and at Mt. Buchanan, Queens County. A natural stand of red pine was found infected at Point Pleasant, Kings County and scattered blue spruce trees were infected in a 12-year-old hedge at Point Prim, Queens County. Sanitation measures are planned in these areas by the provincial forestry agencies.

Prompted by concern over the fate of red pine plantations, silvicultural control (pruning) experiments were carried out in Nova Scotia during the fall of 1988 under the aegis of Forestry Canada. Assessments in the fall of 1989 showed that the number of infected trees was reduced by an average of 25% (range 15-40%) in the three treated plantations while in the non-treated control plantation incidence increased marginally.

Seedling debarking weevil *Hylobius congener* D.T., Sch. & March. - In 1989, the seedling debarking weevil continued to damage newly established plantations in Nova Scotia and Prince Edward Island. However, some losses have been reduced by a program of delayed planting of higher hazard sites. This allows the weevil to complete its life cycle and disperse from the site before seedlings are planted. At the same time, delayed planting can result in alternative weevil-food sources developing on the site which reduce the amount of planted-seedling damage done by any remaining weevils. In Prince Edward Island, site preparation before planting may have reduced losses there. No systematic surveys were conducted in Nova Scotia during 1989.

In Prince Edward Island, information from a survey designed to measure the effects of various site preparation techniques was collected under contract during late fall. Preliminary analysis of the data indicates that 77% of the 60 plantations surveyed had some level of damage (compared with 61% of 51 plantations in 1988) and that most of the damage was found in central and eastern Prince Edward Island. In 30% of the plantations more than 5% of seedlings were damaged, compared to 4% in 1988. The amount of damage appears to be related to the method of site preparation. Little or no damage occurred on sites where rhome disks or anchor chains were used to disturb the soil surface; preparation with brush or root rake did not appear to be effective in preventing damage.

Armillaria root rot *Armillaria* spp. - The disease is widely distributed in the Region and mortality of trees, both young and old, was again common in 1989.

In New Brunswick, this root rot killed at least some trees in 18% of the 255 spruce and pine plantations surveyed. Infection rates were generally low though, mostly in the 2% to 8% range, with higher incidence in occasional plantations. Spruce plantations appear to be more vulnerable to the disease than pine plantations. This difference has been consistent since plantation surveys were started. Armillaria root rot also caused tree mortality in other forest situations. Mature and semi-mature balsam fir, black spruce, red spruce, and white spruce were affected and infection was also found in a thinned area. The highest level of tree mortality was recorded in a semi-mature mixed stand at West Branch, Kent County where 28% of the balsam fir and 8% of the red spruce trees were killed.

Plots established in New Brunswick plantations to study the spread of the disease on different hosts and under different conditions have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. Only the three youngest plots were assessed in 1989 and intensification was observed in only one of the three plots. Trees in older plantations are said to acquire

some resistance to lethal attack by Armillaria root rot, which they retain as long as they are in a vigorous condition without significant stress. Some of the study plantations are reaching this age.

In Nova Scotia, Armillaria root rot killed at least some trees in 18% of the 56 spruce and pine plantations assessed during regular surveys. Infection rates are generally low, mostly in the 2% to 8% range, with higher incidence in occasional plantations. An additional 17 infected spruce or pine plantations were found in the 599 plantations surveyed by staff of Scott Worldwide Inc. They found a 2.8% incidence, much lower than the 18% found during the regular surveys. However, the plantations were much older and this may explain the difference. Scattered trees were also killed in natural stands throughout the Province. Armillaria root rot affected 4% of the black spruce trees in a provenance trial at Little Como Lake, Halifax County and 3% of the trees in a black spruce seed orchard at East Mines Station, Colchester County.

In Prince Edward Island, Armillaria root rot was not found in any of the three plantations assessed in 1989.

Christmas tree pests - Many pests of balsam fir Christmas trees are mentioned elsewhere in this report. The balsam gall midge and the balsam twig aphid are discussed here because of their widespread occurrence both in Christmas tree areas and in natural stands and because they affect the quality and, consequently, the value of Christmas trees.

Balsam gall midge *Paradiplosis tumifex* Gagne population levels, and resulting needle loss, were generally low again throughout the Maritimes but increased slightly and were more widespread than in 1988.

Balsam twig aphid *Mindarus abietinus* Koch infestations were common throughout the Maritimes. Damage increased in Prince Edward Island, decreased in Nova Scotia, and remained about the same in New Brunswick; however, damage levels were generally light, with a few areas suffering moderate shoot damage.

Québec

A survey on the condition of trees in plantations was conducted from July 3 to September 1. Data was collected in 919 plantations on spruce-fir (466 trees) and pine (453 trees).

Spruce budmoth *Zeiraphera canadensis* Mut. & Free. - In Québec, the spruce budmoth is found primarily in the Lower St. Lawrence - Gaspé and Québec City regions, two areas in which considerable reforestation of white spruce is carried out. In the former, 83% of the white spruce plantations contain trees damaged by spruce budmoth. Here, 6.2% of the total number of white spruce planted were affected in 1989, compared with 12.7% in 1988. However, no decline was observed in spruce budmoth population levels. Of the white spruce planted between 1968 and 1984, 10.5% were affected by spruce budmoth. These trees are located in plantations where the populations of the insect are high (eight or more larvae per 15-cm branch sample taken in the upper third of the crown). In 1988, the percentage was 20.2.

In the administrative region of Québec City, spruce budmoth populations are higher near Saint-Jean-Port-Joli and in the Beauce, in the area of Saint-Georges. Elsewhere in the province, the insect is present as far as the region of Montréal, where it damaged 50% of the trees in a plantation near Sainte-Béatrix.

White pine weevil *Pissodes strobi* (Peck) - Throughout Québec the situation of the white pine weevil remained unchanged. In the region of Abitibi-Témiscamingue, white spruce is the preferred host of the white pine weevil, whereas in the Trois-Rivières region, Norway spruce is the main species affected by the insect. The planting of white spruce in Abitibi-Témiscamingue between 1972 and 1984 accounts for barely 5% of all reforestation of white spruce in the province during that period. In 1989, like every year since 1986, damage caused by the white pine weevil was found in four out of every five white spruce plantations in this region, and 11% of all white spruce trees outplanted have been damaged. Elsewhere in the province, the white pine weevil caused very little damage to white spruce.

White spruce is the preferred host of the white pine weevil, Norway spruce being less so. Between 1972 and 1988, 130.5 million Norway

spruce trees were planted in Québec, 73 million between 1972 and 1984. At the provincial level, damage resulting from the white pine weevil was observed in 2.6% of the Norway spruce planted and this was distributed in 38% of the Norway spruce plantations. These figures are very similar to those recorded since 1986, except that the percentage of plantations has increased from 31% to 38%.

The white pine weevil is most active in the Trois-Rivière region. Planting of Norway spruce here accounts for 10% of total provincial reforestation. Damage caused by the white pine weevil has been observed in more than 7% of the Norway spruce. Since 1986, this figure has gradually increased from 2.6% to 7.6%, a significant difference in terms of the number of trees affected. All damage is found in the 6- to 20-year age class.

The Eastern Townships recorded the second highest amount of damage caused by the white pine weevil. Close to 16 million Norway spruce trees have been planted in this region since 1972. This year, damage caused by the white pine weevil was observed in 61% of the Norway spruce plantations. The percentage of trees affected was estimated at close to 7.5%. Since 1986 the number of trees affected has remained virtually unchanged, fluctuating between 5 and 7% annually. These insects always appear to feed on the same trees year after year.

The third highest level of white pine weevil activity was reported in the administrative region of Québec City. Approximately 34 million Norway spruce trees have been planted here since 1972. From 1986 on, damage has been observed every year on 3 to 5% of the Norway spruces in this region. In the Montréal region, where 3 million Norway spruce trees have been planted since 1972, the incidence of damage caused by the weevil was lower than in 1986: in 1986, 10.4% of Norway spruces were affected whereas, in the 1989 survey, no more than 3.5% were affected. The insect was present in the Lower St. Lawrence - Gaspé and Saguenay - Lac-Saint-Jean regions, but caused little damage to Norway spruce.

Damage to white pine plantations caused by white pine weevils was observed primarily in the Montréal region. Although few plantations were visited, there appears to be a high incidence of damaged trees (16%). Considerable recent damage was observed.

Other insects - Redheaded pine sawfly *Neodiprion lecontei* (Fitch) was found only in the Montréal region in 1989. Foliage loss was recorded on 5% of red pines and the incidence of the insect was generally low.

Damage to spruce plantations by the spruce budworm *Choristoneura fumiferana* Clem. was localized in the Lower St. Lawrence - Gaspé region, consistent with previous surveys. Although defoliation was minimal, 15% of the spruce trees were affected.

The European spruce sawfly *Gilpinia hercyniae* (Htg.) primarily affects white spruce over five years in age. This year, although the incidence of this insect was high in the administrative regions of Saguenay - Lac-Saint-Jean, Québec City, and Trois-Rivières, it did not cause appreciable damage. There were less than nine larvae per tree sample infested.

Other insects, such as the Eastern spruce gall adelgid *Adelges abietis* (L.), ragged sprucegall adelgid *Pineus similis* (Gill.), and northern pitch twig moth *Petrova albicapitana* (Busck.), were frequently reported throughout Québec but caused very little damage.

Other diseases - Infections of scleroderris canker *Grammeniella abietina* (Lagerb.) Morelet occur primarily in pine plantations in the 6-20 year age class. In 1989, more than 3% of the pines planted in Québec showed symptoms. The Lower St. Lawrence - Gaspé and North Shore regions were the main areas in which the canker was found. In the former, more and more trees in plantations show symptoms over more than 25% of the foliage.

Since 1972, jack pine has accounted for 20% of all reforestation in Québec; 235.3 million jack pine have been planted (to 1989), 116.9 million between 1972 and 1984. The main regions are Abitibi-Témiscamingue, the Lower St. Lawrence - Gaspé, and Trois-Rivières. Since 1987, the number of jack pine affected by the scleroderris canker has dropped slightly, from 4.2% in 1987 to 2.8% in 1989. However, two regions were seriously infected: the Lower St. Lawrence - Gaspé and the North Shore. Although the number of jack pine

affected by the canker in the Lower St. Lawrence - Gaspé region has remained constant since 1987, there has been an increase in the number of trees in which over 25% of the foliage is affected. In the North Shore region, the difference in the number of trees affected between 1987 and 1989 — 48% and 18.8% — is not significant. Pruning operations carried out over the past two years by the Department have helped to initiate this variation, because the severity of the problem also declined.

Red pine is susceptible to scleroderris canker. Between 1972 and 1988, 42 million red pine were planted in Québec, 27 million of which were planted prior to 1985. Close to 76% of the red pine planted before 1985 are in the Outaouais, Trois-Rivières, Québec City and Montréal regions. The situation in Québec as a whole has not changed since 1987. The number of trees affected is 6.7% of all red pines planted in Québec. The most seriously affected region is Trois-Rivières, where more than 15% of the trees were affected by the canker. However, since 1987, the situation in this region appears to be stable in terms of both the incidence and the severity of the disease.

White pine blister rust *Cronartium ribicola* J.C. Fish. hindered white pine reforestation efforts for many years in Québec. In fact, only 16.2 million white pines were planted between 1972 and 1988. Close to 70% of all white pine planted, was in the Outaouais, Québec City, and Montréal regions. Since 1987, there has been a constant and significant increase in the number of trees affected, from 2.2% in 1987 to 5.0% today. The change has been marked in the Trois-Rivières region, where 9.3% of the trees were affected in 1987, compared with 19.2% in 1989. The number of trees affected in each plantation also increased in this region, from moderate in 1987 (5 to 25% of the trees affected) to high in 1989 (more than 25%). In the Outaouais region, however, a decline in the incidence of white pine blister rust was observed, from 0.8% of trees affected in 1987 to less than 0.2% this year. In the Montréal region, the number of trees affected has remained unchanged, but the severity of the infection in plantations has increased from light (from 2 to 5% of the trees affected) to moderate.

Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka causes damage to jack pine. At the provincial level, very few trees are affected. Nonetheless, there has been a constant increase in this disease in the past three years, from 0.4% in 1987 to 0.6% in 1989. Trois-Rivières has the largest number of trees are affected, and the figure has been rising constantly since 1987 from 0.1% to 0.7% in 1989. On the North Shore, there has been a significant increase in the number of trees affected since 1987, from 0.8% in 1987 to 4.2% in 1989. In the Outaouais region, the number of jack pines affected by western gall rust has dropped significantly, from 0.5% in 1987 to less than 0.2% in 1989.

Every year, 5 to 6% of spruce-fir forests are damaged by late frost injury. This year, the most severely affected regions were Québec City (16.6%), Saguenay - Lac-Saint-Jean (8.5%), and Abitibi-Témiscamingue (4.7%). However, the damage was at trace levels.

Ontario

Plantation surveys in 1989 focused on black spruce in northern Ontario and white pine in southern Ontario. A total of 82 plantations were surveyed — 41 for each species. Two visits were made to each plantation, timed to accommodate the feeding periods of the major pests expected. One hundred fifty trees per plantation were scrutinized on each visit for a total of 6150 trees of each species.

Black spruce insects - The only insect encountered in significant numbers was the spruce budworm. It was found in 17 of the 41 plantations infesting 1777 trees or 29% of the total. Although defoliation in some instances was as high as 60%, the overall average was 5%. All but one of the plantations affected were in the Northwestern and North Central regions. Other potentially destructive insects found included the yellowheaded spruce sawfly, which was recorded on 6 trees or 1% of the total, and the white pine weevil which infested 137 trees or 2.2% of the total. Feeding damage by adult sawyer beetles *Monochamus* sp. was found on 6 trees.

Black spruce diseases - The spruce needle rusts, *Chrysomyxa ledi* and *C. ledicola* were found on 1552 trees, 25% of the total. Average defoliation on affected trees was in the 1% range. Frost damaged approximately 3% of the new shoots on 583 trees or 9.5% of the total.

White pine insects - Insect populations were generally low in the white pine plantations exam-

ined. The most numerous insect was the pine spittlebug, which was found in 13 plantations infesting 492 trees or 8% of the total. The second most abundant insect was the pine bark adelgid, which was present in five plantations on 308 trees or 5% of the total. The white pine weevil infested the leaders of 3% or 185 trees in 21 plantations. The eastern pine shoot borer occurred in 12 plantations infesting 61 trees or 1% of the total.

White pine diseases - White pine blister rust was the most abundant disease, occurring in 22 plantations on 3% or 185 trees. Some 123 of these supported stem cankers caused by the organism. No other diseases were found in any significant numbers. Armillaria root rot occurred in five plantations on <1% of the trees and basal stem cankers of undetermined origin were observed in five plantations on <1% of the trees. Mortality of undetermined cause was recorded in eight plantations, but this affected less than 1% of the total trees.

Prairie Provinces

A number of experimental and other high-value conifer plantations were surveyed for insect, disease, and other damage in Manitoba, Saskatchewan, and Alberta in 1989. In Manitoba, the Department of Renewable Resources (MNR) examined over 7500 trees in 43 renewed (6- to 50-year-old) forests distributed in the southeastern and western regions of the province. These included stands of red, jack, and Scots pines and white spruce. Some mortality and stem defects of the red pine were reported, attributed in part to branch and stem cankers and tip die-back, but causal agents were not readily identified. In the jack pine plantations, western gall rust (*Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka), Warren rootcollar weevil (*Hylobius warreni* Wood), pine tortoise scale (*Toumeyella parvicornis* (Ckll.)), and J-root condition were the important damage agents identified. The J-root condition resulted from machine planting, and trees exhibiting this condition were often leaning and had weakened supporting root systems. Other common damage resulted from snow, hail, snowshoe hare (*Lepus americanus* Erxleben), sapsuckers (*Sphyrapicus varius* (L.)), and the lodgepole terminal weevil (*Pissodes terminalis* Hopping). The white pine weevil (*Pissodes strobi* (Peck)) and snowshoe hare were the most damaging in white spruce plantations.

In the Grand Beach area of Manitoba, where Scots pine was planted in 1971, the pine rootcollar weevil (*Hylobius radicis* Buch.) caused severe tree mortality, which is now 15-43% in four different plantation sites.

Monitoring by Forestry Canada and MNR in Manitoba (1988) was undertaken in jack pine genetic improvement plantations established in 1971 and 1974 for screening of western gall rust infection and resistance. The plantations include 216 families and over 6400 trees. Percentage infection by family varied from 0 to 79.2%, suggesting considerable variability exists in resistance to western gall rust among jack pine populations. A similar survey was conducted in 1989 in Saskatchewan jack pine plantations represented by 216 families and about 10 000 trees, but data analyses were incomplete as of 1989.

In Alberta, genetically selected conifers, mostly less than 10-years-old in nine plantations and distributed from southwestern to northern Alberta, were monitored in 1989. The species represented were white spruce, jack, Scots, and lodgepole pines, and eastern and Siberian larches. In the white spruce plantations, white pine weevil contributed up to 6% (average 3.8%) incidence of top-kill and was present in five of the plantations, while yellowheaded spruce sawfly (*Pikonema alaskensis* (Roh.)) caused light defoliation of 10.2% of trees in one plantation, and Armillaria root rot (*Armillaria ostoyae* (Romag.) Herink) killed 2.0-2.4% of trees in two plantations. In one plantation, the spruce needle rust (*Chrysomyxa ledicola* Lagh.) infected 84% of the spruce seedlings.

The main destructive agents of larch included aphids, probably *Adelges* sp., that infested up to 100% of seedlings in two sites. Grass competition contributed to some decline where seedlings were less than 6-years-old.

The most serious damage on the pine hosts included Warren rootcollar weevil (5-8%), western gall rust (<5%), mouse girdling (up to 18%), northern pitch twig moth (*Petrova albicapitana* (Bsk.)) (5.8-12.5%), and variable injury caused by winter or late-spring frosts.

British Columbia

More than 175 2- to 25-year-old natural and planted conifer stands involving more than 15 000 trees were surveyed in British Columbia in

1989 to identify major pests and environment-related problems and their impact on young stands. All trees were examined in each of 10 or more circular plots at each location. Pines were the major component in about 37% of the sites, spruce in 20%, Douglas-fir in 11%, and hemlock in 4%. The balance contained a mix of at least two conifer species, one site contained mostly cedar, and one was cottonwood. Major pest problems included *Rhizina* root disease, climatic injury, animal feeding damage, and infection of needles by native diseases. Less common but locally significant and damaging pests included pine and spruce terminal weevils, pine root collar weevil, and stem rust cankers.

Rhizina root disease - Rhizina root disease, caused by *Rhizina undulata* Fr., infected and killed newly planted conifer seedlings in 37 of 72 sites slash-burned in 1987 and 1988 in parts of the Cariboo, Nelson, and Prince Rupert regions. Fruiting bodies were present, but seedlings were not affected, at an additional 13 sites and at one plantation in the Kamloops Region. This was the second successive year of significant seedling mortality from this pathogen since being first recorded in British Columbia by FIDS in 1969.

Seedling mortality was greatest in the Prince Rupert Region where up to 74% (average 23%) were killed in 24 sites, up from 14% in 1988. Most seedlings were spruce, pine, and eastern hemlock and, for the first time in British Columbia, western red cedar seedling mortality was linked to the disease. At one plantation where 6% of the seedlings had been killed in 1988, another 17% were killed in 1989.

Seedling mortality increased in the Nelson Region to 17% (range 2 to 39%) in 13 of 48 plantations, from an average of 9% in eight plantations in 1988. Highest mortality was in the East Kootenay where 60% of the seedlings were killed in part of one site. At two of four previously infested sites, seedling mortality increased to 19% and 34% from 6% and 15% in 1988; at the remainder, additional mortality was only 1 or 2%.

About 12% of the Douglas-fir seedlings were killed in a recently burned 55-ha site near Cariboo Lake, and pine seedlings were killed near Canim Lake in the eastern part of the Cariboo Region. These were the first records of seedling mortality related to the fungus in the region since 1983.

Fruiting bodies, but no associated seedling mortality, were common and widely scattered at one site west of Clearwater in the Kamloops Region. There was no evidence of the disease in the Prince George Region where the root disease was collected for the first time in 1988.

Mass fruiting of *Rhizina* in forest situations may follow wildfires or prescribed burns. The fungus normally survives for only a few years and most seedling mortality occurs within the first year of infection. The abundance of fruiting bodies in 1989 could provide enough inoculum to infect some adjacent recently burned sites in 1990, and for 1 to 3 years later.

Black army cutworm - Populations of black army cutworm *Actebia fennica* (Tausch) declined significantly in previously infested areas in interior British Columbia. Seedlings and herbaceous ground cover were very lightly defoliated at two sites in the Prince Rupert Region and only ground cover was affected at one site in the Nelson Region. Larvae but no feeding damage were found at six previously infested sites in the Nelson Region, with very low numbers at widespread sites in the western part of the Prince Rupert Region, and at a site north of Prince George. None was found in the Cariboo and Kamloops regions where larvae had been present in 1988, or in additional sites surveyed in both regions in 1989.

The decline was attributed to natural factors including parasites and an entomopathogen, which reduced populations by up to 42% at 11 sites in three regions in 1988. Additional parasitism in 1989, primarily by dipterans, affected 53% of the larvae at two sites in the eastern part of the Nelson Region and 47% of pupae at one site in the Prince Rupert Region.

The number of cutworm larvae at six areas in the northeastern part of the Nelson Region declined to less than 5/1000 cm^2, from 51/1000 cm^2 in 1988, and there was no current feeding on conifers. About 10% of the spruce seedlings stripped by the cutworm in 1988 over 100 ha at a site east of Mica Dam in the northern part of the region and 16% of the previously stripped Douglas-fir over about 15 ha north of Golden were killed.

Only small numbers of cutworm larvae were present in the Prince Rupert Region where larvae

were numerous in 1988. White spruce seedlings and ground cover were very lightly defoliated at two sites in the eastern part of the region, where defoliation was limited to herbaceous ground cover in 1988. Larvae but no feeding damage were common at 1- and 2-year-old burns in the western part of the region.

Only very small numbers, and no larvae and damage, occurred north and east of Prince George, where seedlings and ground cover were defoliated in 1988.

Following slash burning in 1989 in parts of four forest regions, the numbers of adult males captured in pheromone-baited traps exceeded 10+ or more males in sticky traps at 31 of 81 sites, and 500+ in non-sticky traps at 7 of 87 sites, mostly in the Prince Rupert Region. Each sticky trap was baited with an experimental pheromone and compared with a non-sticky trap containing a commercially produced pheromone that is no longer available.

Animal damage - Feeding damage to conifer seedlings by voles was again common in parts of the Vancouver Region but declined in the Prince Rupert Region. Damage by porcupines was common in the western part of the Prince Rupert Region, increased in the Prince George Region, and occurred for the first time in recent years in the Vancouver Region.

About 80% of western hemlock seedlings in a new plantation near Squamish in the Vancouver Region were killed by high numbers of the meadow vole *Microtus* sp. In a nearby older plantation, 2% were killed, and lateral and terminal leaders on hemlock, cedar, and Douglas-fir were clipped. Vole populations declined in the Prince Rupert Region and no new damage occurred where feeding and seedling mortality were prevalent in 1987-88. Porcupines chewing patches of stem and branch bark continued to kill young and semimature conifers, often in spaced stands, especially in the western part of the Prince Rupert Region where recently killed trees were mapped over 3700 ha, and increasingly in the Prince George Region. Elsewhere, about 3% and 5% of the 10-year-old lodgepole pine at two sites east of Boston Bar in the Vancouver Region were killed; this was the first record of tree mortality caused by porcupines in the region in recent years.

Other pests in young stands and plantations - New attacks by pine terminal weevil *Pissodes terminalis* Hopping averaged less than 5% in 10 of 66 young lodgepole pine stands surveyed across British Columbia; this was a result similar to 1988. Warren root collar weevil *Hylobius warreni* Wood infested only live lodgepole pine and one spruce plantation in four forest regions, and killed 4% of the pine at one site. About 12% of the pine at a site in eastern Prince Rupert Region were girdled at the base. This follows tree mortality of 15% and more than 75% partial girdling seen in previous years. An average of 6% of immature lodgepole pine at 13 sites were infected by blister rusts *Cronartium* spp. but tree mortality, frequently the result of perennial stem cankers, was less than 1%. Immature western white pine in nine plantations in three forest regions were infected by white pine blister rust *Cronartium ribicola* J.C. Fisch. including more than half the trees at one site east of Kimberley, and a third to a half of the trees in stands near Creston, New Denver, and Nakusp in the Nelson Forest Region. Infections by western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirat. were present on lodgepole pine in 32 stands in five forest regions but, usually, except at one site north of Kamloops with 43% infection, less than 15% of the trees were infected. With the increased attention to dwarf mistletoe *Arceuthobium americanum* Nutt. ex Engelm. control less than 5% of the 7- to 17-year-old lodgepole pine in only four plantations were infected, although most infections were on the stems and were severe.

Mortality of new spruce terminals caused by spruce terminal weevil *Pissodes strobi* (Peck) was variable (range 2 to 57%), and averaged 20% in 31 stands in parts of five forest regions. Mortality and deformation of the spruce terminals ranged from 2 to 48% at 11 sites in the Prince Rupert Region, the highest north of Kitimat. Current attack was 17% southwest of Prince George, and only 2% and 3% at two sites east of Prince George, but reached 32% and 51% at two sites in the Goat River drainage. In the Kamloops Region, 57% of the terminals were killed at one site near Barrière, and 16% at a site south of Vavenby. At an additional six sites in the Nelson Region, leader mortality was less than 10%.

Douglas-fir and spruce were infested by Cooley spruce gall adelgid *Adelges cooleyi* (Gill.) in

more than 50 stands in parts of five forest regions. New growth on most Douglas-fir was most severely infested and discoloured at 12 of 18 sites in the Vancouver Region. The new tips of Engelmann, white, and Sitka spruce were infested, discoloured, and swollen by the adelgid at 16 sites in three regions, most severely in parts of the Kamloops and Nelson regions.

Mortality of young lodgepole pine, some Douglas-fir, and occasionally other conifers caused by Armillaria root disease, *Armillaria* sp., occurred at 27 (15%) of the natural and planted sites surveyed, mostly in the Nelson and Kamloops regions. Mortality of lodgepole pine averaged 4% at 13 sites, the highest (25%) in 16-year-old trees near Adams Lake in the Kamloops Region. An average of 7% of the Douglas-fir examined at nine sites were killed, including 21% at Adams Lake east of Kamloops, and 13% at one site in the East Kootenay.

Foliar diseases infected and discoloured several conifer hosts in parts of six forest regions. Infection was generally light, resulting in some premature loss of needles but little change in vigour or form. However, severe infection by larch needle cast *Meria laricis* Vuill. at four sites in the Nelson Region reduced height growth of young western larch by about 30%.

Other Infestations of Provincial Importance

Ontario

Tip blight

Sphaeropsis sapinea Fr.

This disease, widespread in southern Ontario, primarily affects Scots pine and Austrian pine and occasionally other coniferous hosts. Heavy mortality is a frequent result.

In August of 1989, an unusual occurrence of the disease was detected in three black spruce seed orchards in Sioux Lookout District and one in Ignace District. The most severe damage was in the Goodie Lake north seed orchard where 26% of the trees were infected, of which 80% had a large portion of the main stem killed. In most of these cases the entire portion of the stem above the initial branch infection died. Infection levels at the other three seed orchards were much lower — in the 4 to 5% range. Black spruce is an unusual host for this organism and investigation of this occurrence will continue. In addition to the above, an infection was reported on 2-0 Colorado blue spruce seedlings in a Christmas tree nursery bed in North Walsingham Township, Simcoe District.

Abiotic factors

Drought - For the second consecutive year drought damage was widespread in Ontario forests. The cumulative effect was evident over an area of some 242 480 ha. The largest part of the damage occurred in the Algonquin Region where an area of 213 148 ha of damage was mapped which included premature foliage discolouration and leaf drop, crown dieback, and mortality. Branch and whole-tree mortality was recorded within a total area of 8 920 ha with the most extensive areas occurring in the Parry Sound District (4 009 ha) and Bracebridge District (2972 ha). Extensive drought damage was also mapped in the Northeastern Region where 16 972 ha were affected, and in the Eastern Region where 10 991 ha were recorded. Lesser amounts of damage were reported from Huronia District in the Central Region, Owen Sound District in the Southwestern Region, Chapleau District in the Northern Region, and Ignace and Kenora districts in the Northwestern Region. The species most consistently and severely affected were red oak, sugar maple, and trembling aspen with most of the branch and tree mortality occurring on exposed, rocky sites.

British Columbia

Douglas-fir tussock moth

Orgyia pseudotsugata (McDunnough)

Small numbers of larvae and pupae were present in ornamental spruce in urban Kamloops for the second consecutive year. For the first time since 1985, larvae were collected near previously defoliated natural stands and at permanent sample sites in the Kamloops Region. The number of male adults trapped increased for a fourth consecutive year. However, only one to four egg masses were found per site, pointing to a decline in severity.

From 1 to 39 larvae were collected in standard FIDS samples in the eastern part of the Kamloops Region between Savona and Chase, and near Kelowna in the Okanagan Valley. None was found in the Nelson Region.

Pheromone-baited sticky traps placed in Douglas-fir stands selected for the greatest historical frequency of tussock moth in the Kamloops Region trapped an increased number of adult males for the fourth consecutive year. About 1893 adult males were caught in 73% of the traps at 16 of 18 permanent sites, up from 1239 in 58% of the traps at 13 of 17 sites in 1988. An additional 1782 male adults were trapped in 60 of 76 traps in three areas where single traps were placed 1 km apart to more precisely locate the focus of any infestation. In the southwestern part of the Nelson Region, 24 male adults were trapped in 11 of 12 traps at two locations, compared to only one per trap at one location in 1988. Increasing trends over 2 or 3 years, or an average catch of 25 or more male moths per trap per location, indicate potential visible defoliation within two summers. Trap catches reached this level in some areas for the second consecutive year including between Savona and Pritchard and near Winfield.

Climatic injury

Foliage on most conifers, particularly western hemlock and western red cedar, was severely discoloured and some trees were killed in early 1989 at more than 115 widespread areas totalling 22 700 ha in six forest regions. This followed unusually cold temperatures accompanied by strong winds in late January and early February.

Damage was most severe and widespread in the Bella Coola Valley in the Vancouver Region. All classes of western hemlock, western red cedar, Douglas-fir, and lodgepole pine were severely discoloured and defoliated over 9350 ha in 57 areas from near Bella Coola and along Burke Channel to King Island. Many mature and overmature conifers were killed over an additional 1500 ha near Bella Coola.

Loss of foliage was common in the western part of the Prince Rupert Region, particularly on hemlock on exposed sites along the Skeena River Valley where stands over more than 6150 ha were discoloured. Seedlings in exposed plantations in the eastern part of the region lost up to 20% of the previous years needles.

Most western hemlock in patches over more than 7200 ha east of Prince George to McBride and in the Bowron River Valley were lightly discoloured, and bud mortality on white spruce was common on most trees in stands east of Highway 97 in the Prince George Region.

In the eastern part of the Cariboo Region, bud mortality was common in young Douglas-fir and spruce plantations and foliage of most age classes of hemlock, cedar, and Douglas-fir were severely discoloured in more than 30 areas totalling 2600 ha.

Buds on Douglas-fir and western larch in the Flathead and Elk river drainages in the eastern part of the Nelson Region were damaged by frost and cold winds which reduced and delayed the bud flush of trees over about 1100 ha. Engelmann spruce, lodgepole pine, and whitebark pine in the area were also severely discoloured; western hemlock in the northeastern part of the region were lightly discoloured.

Discolouration of conifers was widespread over about 800 ha in the Kamloops Region, most severely south of Kamloops in the Highland Valley. Extensive areas of western red cedar in the North Thompson River drainage, particularly in Wells Gray Provincial Park, were also discoloured, but less severely.

Other Insects, Diseases, and Damage

1989

Newfoundland and Labrador Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Balsam twig aphid *Mindarus abietinus* Koch	Balsam fir	Western and central Newfoundland	Low numbers and light damage.
Birch casebearer *Coleophora serratella* (L.)	White birch	Western and central Newfoundland	Low to high populations. Damage ranged from light to severe.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Western and central Newfoundland	Low to high numbers. Trace to moderate browning.
Black knot *Apiosporina morbosa* (Schw.) Arx	Pin cherry Domestic cherry Damson plus	Throughout Newfoundland	Low to high incidence.
Broom rust *Melampsorella caryophyllacearum* Schroet.	Balsam fir	Western Newfoundland Northern and Avalon Peninsulas	Low to high incidences in all areas.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck.	Black spruce	Newfoundland	A black spruce stand near Gambo had the highest number of affected trees since 1983.
European alder leafminer *Fenusa dohrnii* Tischb.	Speckled alder	Western and central Newfoundland	Low to moderate populations. Light to moderate defoliation recorded.
European pine sawfly *Neodiprion sertifer* Geoff.	Pine	Eastern Newfoundland	A nuclear polyhedrosis virus was sprayed to protect ornamental pine trees.
European poplar canker *Dothichiza populea* Sacc. and Briard	Lombardy poplar	Eastern Newfoundland	High incidence in town of Clarenville. All trees appear infected, with up to 95% of the foliage affected. 10% mortality.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Black spruce White spruce Balsam fir	Western and central Newfoundland Labrador	Populations low. No significant damage.
Fungus gnat *Sciaridae* sp.	White spruce	Central Newfoundland Labrador	New record. Severe damage and some mortality to white spruce seedlings in the Wooddale and the Happy Valley Nurseries.
Gray mould blight *Botrytis cinerea* Pers.	Black spruce Heather	Central and eastern Newfoundland	High incidence on black spruce seedlings in Wooddale tree nursery in central Newfoundland.
Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.)	Black spruce White spruce Balsam fir	Western and central Newfoundland Labrador	Low populations. No significant damage.
Ink spot of aspen *Ciborinia whetzelii* (Seav.) Seav.	Trembling aspen	Western Newfoundland Labrador	Moderate incidence in western Newtoundland where 20% of the foliage along Sop's Arm Road was affected. Low incidence in Labrador.
Larch casebearer *Coleophora laricella* (Hbn.)	Tamarack	Western Newfoundland	Moderate populations. 30% and 50% defoliation recorded at two locations.
Leaf and shoot blight *Venturia macularis* (Fr.) Müll. & Arx	Trembling aspen	Western and central Newfoundland Labrador	Common and widespread. Low and moderate incidences in several areas throughout western and central Newfoundland. The highest incidence was in Beothuck Provincial Park, where 60% of the foliage was affected. A low incidence was also found along Churchill Road in Labrador.

Newfoundland and Labrador Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Leaf spot *Entomosporium mespili* (DC ex Duby) Sacc.	American mountain-ash Hawthorn	Avalon Peninsula	New host record for American mountain ash. Up to 85% of the foliage of ornamental hawthorn dropped prematurely in St. John's area.
Mourning cloak butterfly *Nymphalis antiopa* (L.)	Willow Trembling aspen	Eastern Newfoundland Labrador	Low to moderate numbers. Light to moderate defoliation on few trees.
Needle cast *Isthmiella faullii* (Darker) Darker	Balsam fir	Labrador	Low incidence. 10% of old foliage on one tree affected along Grand Lake Road.
Needle rust *Chrysomyxa ledicola* Lagerh. and *C. ledi* de Bary	Black spruce White spruce Blue spruce	Avalon and Bonavista Peninsulas	Low to high incidence. Up to 70% and 75% of new foliage affected on black spruce and white spruce near Long Harbour and Port Union, respectively.
Milesia fructuosa Faull	Balsam fir	Western Newfoundland Labrador	Low incidence recorded near Deer Lake and along Grand Lake Road in Labrador.
Phomopsis blight *Phomopsis juniperovora* Hahn.	Northern white cedar Red cedar Trailing juniper	Avalon Peninsula	Low incidence. Up to 70% of the foliage affected on ornamentals.
Poplar serpentine leafminer *Phyllocnistis populiella* Chamb.	Trembling aspen Balsam poplar	Western and central Newfoundland	Populations ranged from low to high. Damage in central Newfoundland varied from a trace to severe. Severe damage also recorded in western Newfoundland.
Satin moth *Leucoma salicis* (Linn.)	Trembling aspen Silver poplar	Western, central and eastern Newfoundland	High populations and severe defoliation in eastern Newfoundland. Low to moderate numbers and a trace to light damage elsewhere.
Shoot blight *Sirococcus strobilinus* Preuss	White spruce	Central Newfoundland	Low incidence on approximately 1 hectare of white spruce seedlings.
Shot hole *Coccomyces hiemalis* Higgins	Pin cherry	Eastern Newfoundland	Moderate incidence. Up to 25% of the foliage affected on 80% of the trees in a stand near Thorburn Lake.
Spruce budmoth *Zeiraphera canadensis* Mut. & Free.	White spruce Blue spruce Balsam fir	Western and eastern Newfoundland	Low populations. Moderate damage recorded on blue spruce at Pasadena arboretum.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Black spruce White spruce Balsam fir	Western, central and eastern Newfoundland	Low populations and no significant damage.
Spruce spider mite *Oligonychus ununguis* (Jocobi)	White spruce Blue spruce	Avalon Peninsula	High populations on various spruce species in the St. John's area, causing foliage to turn brown and drop prematurely.
Stem and branch canker *Cytospora chrysosperma* (Pers.) Fr.	American mountain-ash	Avalon Peninsula	Up to 80% of shoots affected on ornamental trees in the St. John's area.
Cytospora sp.	American mountain-ash	Avalon Peninsula	Low incidence. Leaves dying and prematurely dropping off on one ornamental tree in Mount Pearl.
Stem girdle *Cucurbidothis pityophila* (Fr.) Petrak	White pine	Eastern Newfoundland	Low incidence. Up to 10% of branches affected on semi-mature trees in Terra Nova National Park.
Taphrina witches' broom *Taphrina cerasi* (Fckl.) Sadeb.	Pin cherry	Western Newfoundland Labrador	Low incidence. Few trees affected in both localities.
Tar spot *Rhytisma prini* (Schw.) Fr.	Mountain holly	Eastern Newfoundland	New record for Newfoundland. 10% of the foliage affected.

Newfoundland and Labrador Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Threelined larch sawfly *Anoplonyx luteipes* (Cress.)	Tamarack	Western Newfoundland Labrador	Low population and no significant damage.
Uglynest caterpillar *Archips cerasivoranus* (Fitch)	Pin cherry	Western Newfoundland	High number of nests recorded near Little Rapids.
Willow blight *Fusicladium saliciperdum* (All. and Tub.) Lind.	Laurel willow Weeping willow Golden willow	Eastern Newfoundland Avalon and Burin Peninsulas	Up to 20% of the foliage affected on 50% of ornamental willows at St. John's. High incidence on golden willow at Gambo in eastern Newfoundland.
Physalospora miyabeana Fukushi	Laurel willow Weeping willow Golden willow	Eastern Newfoundland Avalon and Burin Peninsulas	This pathogen occurred in conjunction with *Fusicladium saliciperdum*.
Willow leaf beetle *Chrysomela falsa* Brown	Willow Balsam poplar	Western Newfoundland Labrador	Low to moderate numbers. A trace to 50% defoliation in Labrador.
Yellow leaf blister *Taphrina populina* Fr.	Lombardy poplar	Avalon Peninsula	Low incidence. Up to 10% of the foliage affected on ornamentals in urban areas.

Maritimes Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Alder flea beetle *Altica ambiens* LeC.	Alder	Maritime provinces	Overall intensity increased in the Region, with browning moderate or severe in western New Brunswick, light to moderate elsewhere; in Nova Scotia light or moderate throughout, with scattered patches of severe browning in central and western parts; in Prince Edward Island moderate or severe patches in all three counties.
Anthracnose of hardwoods *Discula quercina* (West.) Arx	Black ash White ash Beech	Maritime provinces	In New Brunswick, present at varying intensities on beech and black ash at a few scattered locations; in Nova Scotia, an average of 62% of beech leaves were affected in Inverness and Victoria counties (6 locations); in Prince Edward Island, light and moderate browning on white ash in Prince and Kings Counties.
Anthracnose of maple *Kabatiella apocrypta* (Ell. and Ev.) Arx	Red maple Sugar maple	Maritime provinces	Leaf browning from trace to moderate throughout New Brunswick, the most serious foliage discoloration observed at Petit Pacquetville, Gloucester County, where 39% of the sugar maple leaves were affected; mostly trace to light levels of infection at scattered locations throughout Nova Scotia; except at Black Brook, Inverness Co., where 93% of sugar maple leaves turned brown; only one record of light infection on sugar maple in Prince Edward Island.
Ants	Conifers	Maritime provinces	Not nearly as common in plantations in Prince Edward Island as in 1988. No reports from New Brunswick and Nova Scotia.
Ash rust *Puccinia sparganioides* Ell. & Barth.	Ash	Nova Scotia	Chronic infection continued in many parts of Nova Scotia and severe damage occurred in some areas.
Ash yellows	Ash	Maritime provinces	Not found in the Region to date, but a close watch is being kept. This disease is present in the United States and is of concern to plant quarantine officials.
Aspen leafrollers *Epinotia criddleana* (Kft.) *Pseudexentera oregonana* (Wlshm.) Darkheaded aspen leafroller *Anacampsis innocuella* (Zell.) Lightheaded aspen leafroller *Anacampsis niveopulvella* (Cham.) Spotted aspen leafroller *Pseudosciaphila duplex* (Wlshm.)	Trembling aspen	Maritime provinces	Leafrolling remained at trace or light levels throughout the Region. Leafrolling at Aylesford East, Kings Co., Nova Scotia declined for the second consecutive year, to 9%, from 35% in 1988.
Aspen webworm *Tetralopha aplastella* (Hlst.)	Aspen	Maritime provinces	Leafrolling at light levels at 4 locations in New Brunswick; trace at 2 locations in Nova Scotia. No reports from Prince Edward Island.
Atmospheric impurities	White pine	Maritime provinces	No reports in 1989.
Bagworm *Thyridopteryx ephemeraeformis* Haw.	White pine	Maritime provinces	Found at one location in Lunenburg County, N.S. No reports from New Brunswick or Prince Edward Island.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Balsam bark weevil *Pissodes dubius* Rand.	Balsam fir Red spruce	Maritime provinces	Common on dead and dying balsam fir in New Brunswick (average of 6% of trees at five locations in five counties). Collected at one location from red spruce in Nova Scotia. No reports from Prince Edward Island.
Balsam fir bark beetle *Pityokteines sparsus* (LeC.)	Balsam fir	Maritime provinces	Present throughout much of New Brunswick in weakened trees. Highest infestation at West Branch, Kent County (28% of trees infested). No reports from Nova Scotia or Prince Edward Island.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir	Maritime provinces	A few larvae at scattered locations throughout the region.
Balsam gall midge *Paradiplosis tumifex* Gagn.	Balsam fir	Maritime provinces	Populations remained low but increased considerably in distribution and in intensity over last year's levels. A few spot infestations caused severe or moderate needle damage in New Brunswick and Nova Scotia.
Balsam shootboring sawfly *Pleroneura brunneicornis* Roh.	Balsam fir	New Brunswick Nova Scotia	Widespread but caused only light shoot damage in New Brunswick. Only three reports of light damage in Nova Scotia.
Balsam twig aphid *Mindarus abietinus* Koch.	Balsam fir	Maritime provinces	In Nova Scotia scattered trees with associated foliage discolouration in Colchester and generally caused only light shoot damage but was common throughout the Maritimes at population levels which increased in Prince Edward Island, decreased somewhat in Nova Scotia, and remained about the same as last year in New Brunswick. Moderate damage occurred in a few isolated areas.
Balsam woolly adelgid *Adelges piceae* (Ratz.)	Balsam fir	Maritime provinces	Attacks resulting in stem-wool and gouty twigs were found in several coastal areas in New Brunswick. In Nova Scotia most of the affected trees were found on Cape Breton Island, where at some locations gouty twigs were present on all trees. Affected trees were observed in central Prince Edward Island.
Beech bark disease *Nectria coccinea* var. *faginata* Lohm., Wats. & Ayers Beech scale *Cryptococcus fagisuga* Lind.	Beech	Maritime provinces	Cankered trees common throughout the Region. Average of cankered trees 80% in New Brunswick (8 locations), 79% in Nova Scotia (8 locations), and 87% in Prince Edward Island (4 locations).
Birch casebearer *Coleophora serratella* (L.)	Alder White birch Wire birch Yellow birch	Maritime provinces	Populations increased significantly in Prince Edward Island, decreased in Nova Scotia, and remained stable in New Brunswick. Average foliage browning of white birch was almost 50% in P.E.I., 20% in N.B., and 13% in N.S. Wire birch and yellow birch were also affected to some extent.
Birch leafminer *Fenusa pusilla* (Lep.)	Wire birch White birch	Maritime provinces	Severe foliage discolouration of wire birch in a few areas in Nova Scotia, leaf browning elsewhere in the Province light or moderate. Populations low in New Brunswick and Prince Edward Island, causing only trace to light discolouration in most places.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Birch leaf spot *Septoria betulina* (Lib.) West	White birch	New Brunswick Nova Scotia	Often occurs in close association with unexplained foliage discolouration of white birch along the Bay of Fundy; in New Brunswick, an average of 31% of leaves affected (13 locations;,highest 81%). Common in Nova Scotia, found in seven mainland countries and throughout Cape Breton Island, associated with discolouration.
Birch sawfly *Arge pectoralis* (Leach)	Speckled alder Wire birch	New Brunswick Nova Scotia	Trace or light defoliation at a few scattered locations, except at Nashwaak River, York Co., New Brunswick, where speckled alder was moderately defoliated.
Birch skeletonizer *Bucculatrix canadensisella* Cham.	White birch	Nova Scotia	Widespread in Nova Scotia and caused extensive foliage browning of white birch, especially in Cumberland county.
Black leaf blister *Taphrina dearnessii* Jenkins	Red maple	Maritime provinces	Present at low levels in all three provinces.
Brown felt blight *Herpotrichia juniperi* (Duby) Petr.	White spruce	Nova Scotia	Found at four scattered locations on dense white spruce regeneration. At Barrio Deadwater, Digby Co., 39% of lower foliage affected on a small clump of young trees.
Bruce spanworm *Operophtera bruceata* (Hulst)	Red maple Sugar maple Trembling aspen	Maritime provinces	Single collections from Northumberland Co., New Brunswick and Cumberland, Pictou, and Queens counties, Nova Scotia. No reports from Prince Edward Island.
Canker of larch *Potebniamyces coniferarum* (Hahn) Smerlis	Tamarack	Maritime provinces	Found at two locations in New Brunswick and one location each in Nova Scotia and Prince Edward Island.
Cedar leafminers *Argyresthia aureoargentella* Brower *Argyresthia freyella* Wlshm. *Argyresthia thuiella* (Pack.) *Coleotechnites thujaella* (Kft.)	Cedar	New Brunswick Prince Edward Island	Present at Latimer Lake, St. John Co., New Brunswick, where 76% of the shoots were affected on 100% of the trees; populations low elsewhere. In Prince Edward Island, trees continued to deteriorate in the Muddy Creek, Miscouche, and Wellington areas of Prince Co.
Cherry blight	Choke cherry Pin cherry	Maritime provinces	Present throughout most of the Region, much more common in 1989 than 1988. Common in: Charlotte, Kent, Gloucester and Restigouche counties, New Brunswick; Inverness and Cape Breton counties, Nova Scotia; and Queens Co., Prince Edward Island.
Cherry casebearer *Coleophora pruniella* Clem.	Pin cherry Trembling aspen	Maritime provinces	At endemic levels in New Brunswick and Nova Scotia. In Prince Edward Island, leaf browning of trembling aspen moderate and severe in 6 ha at Lower Newtown, Queens Co., moderate in small aspen stands and hedgerows at Kilmuir and Commercial Cross, Kings Co., and on most trees at Orwell, Queens Co.
Cone rusts *Chrysomyxa pirolata* Wint. *Pucciniastrum americanum* (Farl.) Arth.	White spruce Red spruce	Maritime provinces	*P. americanum* was found at Waterville, Kings Co., Nova Scotia where it affected about 5% of the cones on 30% of the trees in a clonal seed orchard. *C. pirolata* was not found in 1989.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Deterioration of cedar	Cedar	New Brunswick Prince Edward Island	In New Brunswick, condition of trees improved in Charlotte and St. John counties, except at Latimer Lake area, St. John Co., where tree condition declined further. Damage by the cedar leafminer complex increased; however the initial cause of the deterioration remains uncertain. In Prince Edward Island, tree deterioration continued in the Muddy Creek area of Prince Co., where some trees died and others had dead branches or tops.
Diplodia tip blight *Sphaeropsis sapinea* (Fr.) Dyko & Sutton	Red pine	Nova Scotia	Trace shoot damage on 6% of young plantation trees in Queens County.
Drought and hardwood branch mortality	Hardwoods	Maritime provinces	The severe branch mortality on ornamental and roadside hardwoods, reported from New Brunswick and Prince Edward Island in 1988, did not recur in 1989. The branches which died in spring 1988 were still present on the affected trees. Severely stressed trees either suffered further branch mortality or died. In Fredericton, York Co., N.B. 27 large maples (diameter greater than 40 cm) in poor condition were removed along sidewalks as part of the City's sanitation effort.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir Red spruce White spruce	Maritime provinces	A few larvae at numerous locations throughout the Region.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck	Spruce	Maritime provinces	Found at scattered locations in the Region, the highest number of brooms recorded at Doctor's Brook, Antigonish Co., and Dunvegan, Inverness Co., Nova Scotia, where 44% and 40% of trees had at least one broom each, respectively.
Eastern larch beetle *Dendroctonus simplex* Lec.	Larch	Maritime provinces	Population buildup was first noticed in Nova Scotia in 1976. This increase in the beetle population followed several years of severe defoliation of larch by the larch sawfly, *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespred in all three provinces and caused serious tree mortality. By the end of 1981, an estimated 24% of merchantable-size larch was dead in New Brunswick, 65% in Nova Scotia, and 13% in Prince Edward Island. The insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.
Eastern spruce gall adelgid *Adelges abietis* (L.)	Red spruce White spruce	Maritime provinces	Present throughout region, generally at trace to light infestation levels.
Eastern tent caterpillar *Malacosoma americanum* (F.)	Apple Cherry	Maritime provinces	More common throughout the Region than in 1988, except in the northern counties of New Brunswick.
Elm leaf aphid *Tinocallis ulmifolii* (Monell)	Elm	New Brunswick	No reports in 1989.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Elm leaf beetle *Pyrrhalta luteola* (Mull.)	Elm	New Brunswick	Severe foliage browning in Fredericton, York Co., a dramatic increase from trace levels in 1988.
Elm leafminer *Fenusa ulmi* Sund.	English elm Rock elm	Maritime provinces	In New Brunswick, severe browning on exotic elms at Sackville, Dorchester, and Moncton, Westmorland Co., and Riverview, Albert Co. In Nova Scotia and Prince Edward Island, moderate and severe browning of exotic elms at most places.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Scots pine Pine	Maritime provinces	Less common in Nova Scotia than in 1988, with moderate defoliation on Scots pine at Little Bras d'Or, Cape Breton Co. No reports from New Brunswick and Prince Edward Island.
European pine shoot moth *Rhyacionia bouliana* (D. & S.)	Red pine	Maritime provinces	In New Brunswick, recorded only in a plantation at Penobsquis, Kings Co., where shoot damage was widespread. In Nova Scotia, light damage on 70% of 1-m high trees in a plantation west of Hastings, Annapolis Co., elsewhere trace shoot damage common. In Prince Edward Island, severe shoot damage, with nearly all shoots on some trees infested at North and South Granville; moderate damage (37%) on nearly all trees at Auburn Woodlot; light damage on 80% of trees in a 1-m high plantation between Darnley and Irishtown, Queens Co.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Spruce	Maritime provinces	Populations low throughout the Region.
Fall cankerworm *Alsophila pometaria* (Harr.)	Hardwoods	Maritime provinces	Populations low throughout the Region. Trace to light defoliation on ornamentals in Truro, Nova Scotia.
Fall webworm *Hyphantria cunea* (Dru.)	Deciduous	Maritime provinces	Nests much more common in all three provinces than in 1988, especially in southeastern Kent Co., New Brunswick, in the central and western counties in Nova Scotia, and throughout Prince Edward Island.
Flat leaftier *Psilocorsis* sp.	Hardwoods	Maritime provinces	Trace or light amounts of leaf tying at several locations in New Brunswick and Nova Scotia, except in some areas of Queens County, Nova Scotia where moderate damage occurred on red oak. No reports from Prince Edward Island.
Forest tent caterpillar *Malacosoma disstria* Hbn.	Hardwoods	Maritime provinces	Populations very low throughout the Region. Light defoliation present in Antigonish Co., Nova Scotia and a few larvae were collected at scattered locations. Not observed in Prince Edward Island. Light-trap catches and pheromone surveys indicate a population increase is in the offing, especially in New Brunswick.
Foureyed spruce bark beetle *Polygraphus rufipennis* (Kby.)	Black spruce Red spruce White spruce	Maritime provinces	Found at nine scattered locations in New Brunswick with an average of 7% trees attacked. Few insects collected at two locations in Colchester and Kings counties, Nova Scotia. No record in Prince Edward Island.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Frost damage	Conifers Hardwoods	New Brunswick Nova Scotia	Widespread damage throughout northern New Brunswick on balsam fir, and to a lesser extent white spruce; shoot damage severe on balsam fir at South Tracadie River and Teagues Lake Road, Gloucester Co. In Nova Scotia, an average of 7% of shoots damaged at 36 locations in nine counties, the highest damage being 27% of new shoots of balsam fir killed at Cape Blomidon, Kings Co.
Globose gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Mugho pine Scots pine	Maritime provinces	Scattered in plantations and on ornamentals throughout the Region. Widespread in southern New Brunswick in jack pine plantations, and in natural stands, common on ornamental species; 56% of trees infected at Le Castor, Kouchibouguac National Park. In Nova Scotia, highest incidence at West Leicester, Cumberland Co., with 8% of trees infected in a Scots pine plantation.
Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.)	Spruce	Maritime provinces	Population low throughout.
Greenstriped mapleworm *Dryocampa rubicunda rubicunda* (F.)	Red maple	Maritime provinces	Population remained low in New Brunswick with only trace defoliation on a few trees in Westmorland Co. light defoliation in an area of Lunenburg Co., Nova Scotia; no reports from Prince Edward Island.
Hail damage	Conifers Hardwoods	Maritime provinces	No reports in 1989.
Hypoxylon canker *Hypoxylon mammatum* (Wahl.) Mill.	Trembling aspen	Maritime provinces	Present throughout the Region: in New Brunswick, an average of 13% of trees infected at 23 locations in 10 counties; in Prince Edward Island at three locations with an average of 8% trees infected. No comparable figure available from Nova Scotia but mortality levels generally low.
Ink spot of aspen *Ciborinia whetzelii* (Seav.) Seav.	Trembling aspen Poplar	New Brunswick	Found at a few scattered locations at trace or light infection levels.
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	Maritime provinces	No significant defoliation occurred in the Region in 1989. However, catches in pheromone traps increased considerably from previous years in northeastern New Brunswick, indicating a population increase in the area.
Larch casebearer *Coleophora laricella* (Hbn.)	Larch	Maritime provinces	Much more common than during the past few years and caused severe or moderate foliage discoloration in many areas, mostly in Nova Scotia and western Prince Edward Island.
Larch needleworm *Zeiraphera improbana* (Wlk.)	Tamarack	Nova Scotia	Trace defoliation in an area of Inverness County.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Larch sawfly *Pristiphora erichsonii* (Htg.)	Japanese larch Tamarack	Maritime provinces	Defoliation severe and moderate on experimental Japanese larch at MacDonald's Corner, Queens Co., New Brunswick; trace defoliation occurred in Westmorland and York Counties. In Prince Edward Island, defoliation declined to trace at St. Lawrence and near Bloomfield, Prince Co., where it was severe on scattered trees in 1988. No reports from Nova Scotia.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Maritime provinces	At endemic levels throughout.
Leaf and twig blight of aspen *Venturia macularis* (Fr.) Müll. & Arx	Largetooth aspen Trembling aspen Hybrid poplar	Maritime provinces	Shoot damage similar in intensity but less common than in 1988: in New Brunswick averaged 10% (18 locations, highest 20%), in Nova Scotia 4% (10 locations, highest 24%) and in Prince Edward Island shoot damage was light.
Leaf blister *Taphrina carnea* Johanson	Yellow birch	Maritime provinces	At scattered locations throughout New Brunswick, with average of 18% of leaves infected. In Nova Scotia, infection averaged 19%. One location in Prince Edward Island had 12% of leaves infected.
Leaf blotch of horse-chestnut *Guignardia aesculi* (Pect.) V.B. Stew.	Horse-chestnut	Maritime provinces	Found wherever host occurs throughout the Region but intensity of browning was reduced from 1988: in New Brunswick, leaf browning was trace (from light in 1988); in Nova Scotia, light and moderate browning with only scattered trees with severe damage (from generally severe in 1988), and in Prince Edward Island leaf browning was only trace or light.
Leaf spot of poplar *Drepanopeziza tremulae* Rimpau	Largetooth aspen Trembling aspen	Maritime provinces	Foliage browning of varying intensity in a few scattered areas in all three provinces. Browning moderate to severe in New Brunswick, in Carleton County, light to moderate in Nova Scotia, and from light to severe in Prince Edward Island.
Lesser aspen webworm *Meroptera pravella* (Grt.)	Trembling aspen	Maritime provinces	No reports in 1989.
Lesser maple spanworm *Itame pustularia* (Gn.)	Red maple	Maritime provinces	Few larvae throughout Nova Scotia and Prince Edward Island. No reports from New Brunswick.
Maple leafroller *Sparganothis acerivorana* MacK.	Red maple Sugar maple	Maritime provinces	Leaf rolling was light in New Brunswick (31 locations in nine counties), the highest being 21% of leaves affected on 90% of trees at Cranberry Lake, Queens Co. Less than 5% of leaves rolled at two locations in Prince Edward Island. No reports from Nova Scotia.
Maple spindlegall mite *Vasates aceris-crumena* (Rly).	Sugar maple	Maritime provinces	Common on sugar maple foliage throughout the Region, affecting an average of 31% of leaves in New Brunswick, 34% in Nova Scotia, and 24% in Prince Edward Island. As much as 93% of the leaves were found infested in an area in northern New Brunswick, covering the leaves with unsightly spindles and affecting the aesthetic appearance of shade trees.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Mites *Oligonychus milleri* (McGregor) *Oligonychus ununguis* (Jacobi)	Jack pine Red pine Balsam fir Red spruce	Maritime provinces	No reports in 1989.
Mottled and discoloured foliage	Conifers Hardwoods	Maritime provinces	Various types of foliage discolouration, occurring at various intensity levels and probably caused by a variety of undetermined factors, were observed in New Brunswick, on black spruce and red maple in Kent Co., on red pine in Yarmouth Co., on largetooth aspen in Annapolis, Hants, and Kings counties, tamarack in Inverness Co., on hemlock in Hants Co., on balsam fir in Lunenburg, Antigonish, and Halifax counties, on white spruce in Antigonish and Colchester counties, and on red spruce in Annapolis County. No reports from Prince Edward Island.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Maritime provinces	Few larvae found only at one location in each of Nova Scotia and Prince Edward Island. Not found in New Brunswick.
Needle casts *Davisomycella ampla* (Davis) Darker	Jack pine	Maritime provinces	No reports in 1989.
Isthmiella faullii (Darker) Darker	Balsam fir	New Brunswick Nova Scotia	Severe browning on scattered trees at Skin Gulch, Victoria Co., and trace at a location in Madawaska Co., New Brunswick; light in one area each in Cumberland and Inverness Counties, Nova Scotia.
Lirula macrospora (Htg.) Darker	Black spruce Red spruce White spruce	Maritime provinces	Severe to moderate browning in black spruce plantations in Victoria Co., and light on red spruce in Queens and Kings counties, New Brunswick; light or trace browning in Nova Scotia except at Two Mile Lake, Halifax County, where 31% of red spruce needles were affected; only trace needle browning observed at one location in Prince Edward Island.
Lirula nervata (Darker) Darker	Balsam fir	Maritime provinces	Infection levels low; few locations.
Phaeocryptopus gaeumannii (Rohde) Petr.	Douglas fir	New Brunswick Nova Scotia	Severe on 1988 foliage in a 1-ha plantation near Tay Falls, York Co., New Brunswick. Infected 10% of old foliage of plantation trees at West Leicester, Cumberland Co., Nova Scotia.
Northern cedar bark beetle *Phloeosinus canadensis* Sw.	Cedar	New Brunswick	No observations in areas of Carleton County in 1989 where they occurred in 1987 and, in reduced numbers, in 1988.
Northern pitch twig moth *Petrova albicapitana* (Busck.)	Jack pine	Maritime provinces	Widespread but at low populations in jack pine plantations and natural stands in New Brunswick, averaging 14% of trees infested at eight locations. In Nova Scotia, 56% of jack pine trees affected at Battery Lake, Pictou County, and light infestation in an area in Guysborough County. Present on a few jack pine branches at Goose River, Kings Co., Prince Edward Island.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Oak leafroller *Pseudexentera spoliana* (Clem.) and Oak leafshredder *Croesia semipurpurana* (Kft.)	Red oak	Maritime provinces	Both insects caused serious defoliation of oak over 8 200 ha in western Nova Scotia (mainly leafroller), in a few localized areas of New Brunswick (mainly leafshredder), and in Prince Edward Island (both species). The outbreak in Nova Scotia decreased from 1988 in both area affected and intensity. Deterioration of stands continued, however, and only 1% of over 1 000 trees assessed were classified as healthy in 1989.
Oak leaf rust *Cronartium quercuum* (Berk.) Miyabe	Oak	New Brunswick	*C. quercuum* (alternate host: jack pine), was found in 1988 for the first time in the Maritimes on leaves of red oak in a collection from Northumberland County, New Brunswick. Not found anywhere in the Region in 1989.
Oblique-banded leafroller *Choristoneura rosaceana* (Harr.)	Beech Red maple Sugar maple Trembling aspen White birch Wire birch Yellow birch	Maritime provinces	More common in New Brunswick in 1989 than in recent years, causing light leaf rolling. Observed at a few scattered locations in Nova Scotia, and Prince Edward Island with only a few leaves rolled.
Ocean salt spray	Spruce	Maritime provinces	Trace foliage browning on exposed coastal trees in Prince Edward Island National Park. No reports from New Brunswick and Nova Scotia.
Ocellate gall midge *Acericecis ocellaris* (O.S.)	Red maple Sugar maple	Maritime provinces	Common throughout Region, affecting the appearance of heavily infested leaves.
Orange-humped mapleworm *Symmerista leucitys* Francl.	Beech	Maritime provinces	Populations generally low. A few larvae found feeding on beech at two locations in Kejimkujik National Park, Queens Co., Nova Scotia. No reports from New Brunswick or Prince Edward Island.
Orange spruce needleminer *Coleotechnites piceaella* (Kft.)	Balsam fir Black spruce Red spruce	Maritime provinces	Populations low but present at several locations in all three provinces, mining up to 8% of needles.
Pepper-and-salt moth *Biston betularia cognataria* (Gn.)	Yellow birch Tamarack	Maritime provinces	Light defoliation of yellow birch in Fundy National Park, New Brunswick; present on scattered plantation tamarack trees in Prince Co., Prince Edward Island; no reports from Nova Scotia.
Pine bark adelgid *Pineus strobi* (Htg.)	Pine	Maritime provinces	Present on 60% of branches in 30% of white pine at Kent Lake, Kent Co., New Brunswick; found on white pine at 10 scattered locations in Nova Scotia, averaging 20% of trees affected. Highest count 61% of trees infested at Brooklyn Corner, Kings Co.; no reports from Prince Edward Island.
Pine engraver *Ips pini* (Say)	Jack pine	New Brunswick	Larvae present in root collar area of two recently-killed jack pines in a 1975 plantation in Gloucester Co., New Brunswick.
Pine leaf adelgid *Pineus pinifoliae* (Fitch)	White pine Red spruce	Nova Scotia	Infestations affected 36% of white pine shoots. Galls were formed on 17% of red spruce shoots in western Nova Scotia, an increase from the previous year. Shoot mortality of white pine was 7% in the fall, with more mortality expected.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Pink-striped oakworm *Anisota virginiensis virginiensis* (Drury)	Red oak	Maritime provinces	No reports in 1989.
Poplar flea beetle *Altica populi* Brown	Balsam poplar	New Brunswick	Severe foliage browning at Oromocto Lake, Sunbury Co., and Prince William, York Co. Elsewhere, very common in southern York County and in most of Charlotte County, causing light or moderate browning.
Poplar leaf-folding sawfly *Phyllocolpa* sp.	Trembling aspen	Maritime provinces	In New Brunswick, 23% of leaves folded on 92% of trees examined at 28 locations; highest at Rankin Brook, Kent Co., all trees were affected and 73% of leaves folded. In Nova Scotia, 8% of leaves folded on 57% of trees at 31 locations; highest at Mill Brook, Cape Breton Co. where 52% of leaves were affected. In Prince Edward Island, 36% of leaves were affected on 83% of trees at 15 locations; highest at North Enmore, Prince Co. with 85% of folded leaves.
Poplar leafmining sawfly *Messa populifoliella* (Town.)	Trembling aspen Balsam poplar	Maritime provinces	In New Brunswick, populations much lower than in 1988 in Kings and Restigouche counties; light mining of trembling aspen also in Northumberland County, and of balsam poplar in Victoria County. In Nova Scotia, trace browning of trembling aspen in Annapolis County. No reports from Prince Edward Island.
Poplar petiolegall moth *Ectoedemia populella* Busck	Trembling aspen	Nova Scotia Prince Edward Island	In Nova Scotia, 55% of petioles infested at Black River, Kings Co., elsewhere an average of 14% of leaves affected (eight locations).
Poplar serpentine leafminer *Phyllocnistis populiella* Cham.	Trembling aspen	Maritime provinces	Outbreaks continued in northern New Brunswick, affecting an average of 61% of the foliage on 98% of trees. As a result of repeated severe attacks, leaves of trembling aspen are smaller than normal, trees appear generally unhealthy, and twig dieback is evident in some areas. Populations are lower in southern New Brunswick and generally very low in Nova Scotia and Prince Edward Island. All petioles of all trees affected at Goose River, Kings Co., Prince Edward Island.
Porcupine damage	White birch Balsam fir Jack pine Red pine White pine Black spruce Red spruce White spruce Tamarack	New Brunswick Nova Scotia	Damage common throughout New Brunswick and Nova Scotia. Most serious damage recorded (28% of trees) at Union Corner, Carleton Co., N.B., on white pine, and at Ingramport, Halifax Co., N.S. on red pine.
Premature needle loss	Black spruce	New Brunswick	Premature needle loss of one-year-old needles in plantations was only 8% in 1989, compared to 52% in the spring of 1988. The cause of the condition remains unknown.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Rabbit damage	Black spruce White spruce	Maritime provinces	A few scattered reports from central Nova Scotia. In Prince Edward Island, damage moderate on white spruce at the Brookvale Demonstration Woodlot, Queens Co., and light on black spruce at East Bideford, Kings County. No reports from New Brunswick.
Ragged spruce gall adelgid *Pineus similis* (Gill.)	Black spruce Red spruce White spruce	Maritime provinces	Light shoot damage at scattered locations in Nova Scotia and Prince Edward Island. No reports from New Brunswick.
Red flag of balsam fir *Fusicoccum abietinum* (Hartig) Prill. & Delacr.	Balsam fir	Nova Scotia	Common in western Nova Scotia; moderate along roadsides, with one or two flags per tree.
Redheaded jack pine sawfly *Neodiprion virginiana* complex	Jack pine Scots pine	Maritime provinces	No reports in 1989.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	Maritime provinces	Found on one small red pine tree at Masstown, Colchester Co., Nova Scotia. No reports from New Brunswick or Prince Edward Island.
Red spruce adelgid *Pineus floccus* (Patch)	Black spruce Red spruce	Maritime provinces	No reports in 1989.
Resin flow	White spruce	Prince Edward Island	A continuing problem on underside of white spruce branches in southern Kings Co. Cause unknown.
Roadside salt damage	Conifers Hardwoods	Maritime provinces	Foliage discolouration, mostly of white pine and red pine, severe or moderate on roadside trees throughout the Region. Dieback of hardwoods common along the Trans Canada Highway, especially from Wentworth Valley, Cumberland Co., to Folly Lake, Colchester Co., Nova Scotia.
Saddled prominent *Heterocampa guttivitta* (Wlk.)	Beech White birch	Maritime provinces	Defoliation of white birch light at one location in Gloucester Co., New Brunswick and trace on beech in Kings and Digby Counties, Nova Scotia. No reports from Prince Edward Island.
Satin moth *Leucoma salicis* (L.)	Carolina poplar Silver poplar Trembling aspen	Maritime provinces	Populations continue to decrease in New Brunswick, only trace defoliation of silver poplar at St. Leonard, Madawaska Co., where defoliation was severe in 1988. Populations increased in Nova Scotia, causing defoliation at several locations in Annapolis, Antigonish, Lunenburg, and Richmond counties. In Prince Edward Island, severe and moderate defoliation of ornamental poplars in many areas.
Snow damage	Conifers	Maritime provinces	Scattered throughout Region, usually little damage; but at Little South Tracadie River, Gloucester Co., New Brunswick, stems of 24% of 3-5 m high jack pine trees were broken, and 28% of red pine trees were damaged at Little River, Cumberland Co., Nova Scotia.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Spearmarked black moth *Rheumaptera hastata* (L.)	Trembling aspen White birch Wire birch Yellow birch	New Brunswick Nova Scotia	Populations increased greatly in New Brunswick and were highest on white birch in the northern half of the Province where an average of 11% of white birch foliage was brown on 69% of the trees, the most serious browning observed at Bald Peak, Victoria Co.; 45% of the leaves on all trees were affected. Only one larva found in Nova Scotia.
Spittlebugs *Aphrophora* sp. *Cercopidae* sp.	Conifers Red oak Red maple White birch	Maritime provinces	Population generally low in the Region, the highest observed at Little River, Colchester Co. Nova Scotia, where 44% of balsam fir trees were affected.
Spotted tussock moth *Lophocampa maculata* Harr.	Alder	New Brunswick	Few larvae at scattered locations.
Spring cankerworm *Paleacrita vernata* (Peck)	White birch	Maritime provinces	At endemic levels.
Spruce bud midge *Rhabdophaga swainei* Felté	Black spruce Red spruce White spruce	Maritime provinces	Populations low but widespread throughout.
Spruce bud scale *Physokermes piceae* (Sch.)	Black spruce Red spruce White spruce	Maritime provinces	Present at generally low populations at widely scattered locations in the Region, except in: (a) New Brunswick, moderate at Bartibog, Northumberland Co., where 44% of branches were infested on 60% of black spruce, moderate or light on scattered black spruce in a seed orchard in Albert County; (b) Nova Scotia where moderate at Trafalgar, Guysborough Co., with 43% of black spruce branches affected; (c) Prince Edward Island where moderate at Foxley River, Prince Co., with 44% of white spruce branches infested on 50% of trees.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Jack pine White spruce	Maritime provinces	Populations generally low in Region. See under: Seed orchard pests.
Spruce gall adelgid *Adelges lariciatus* (Patch)	Spruce White spruce	Maritime provinces	Population low.
Spruce micro moth *Coleotechnites atrupictella* (Dietz)	White spruce	Prince Edward Island	A few larvae in Queens and at Prince Counties.
Spruce twig aphid *Mindarus obliquus* (Cholod.)	Red spruce White spruce	Maritime provinces	Still widespread in Nova Scotia but less damage than in 1988. The province had an average of 5% of shoots affected at 18 locations (highest 39% on red spruce at Lake Paul, Kings Co.). In Prince Edward Island, an average of 5% of shoots were affected on 37% of white spruce (highest 13% on 50% of trees west of Brackley, Queens Co.). No reports from New Brunswick.
Sugar maple borer *Glycobius speciosus* (Say)	Sugar maple	Maritime provinces	Present in many sugar maple stands in the Region. In New Brunswick, 24% of trees affected at Petit Paquetville, Gloucester Co.; in Nova Scotia, 8% of trees infested near Moose River, Cumberland Co.; in Prince Edward Island, one affected tree at Valleyfield, Kings Co.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Sulphur dioxide damage	Conifers Hardwoods	New Brunswick	Trees continue to deteriorate in a plantation and in natural stands near Brunswick Mines, Gloucester County.
Tar spot of maple *Rhytisma acerinum* (Pers. ex St. Amans) Fr.	Maple	New Brunswick Nova Scotia	Present at scattered locations but more common in Nova Scotia, where an average of 36% of red maple foliage affected at 19 locations (highest, 97% of red maple leaves at Middle Beaver Lake, Halifax Co.).
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Cherry	Maritime provinces	Still common in all three provinces. In New Brunswick, found at more locations but at lower populations than in 1988; in Nova Scotia the highest nest counts were in the Truro area of Colchester Co.; in Prince Edward Island remains widespread but less common.
Wax filament scale *Xylococculus betulae* (Perg.)	Beech White birch Yellow birch	Maritime provinces	Throughout New Brunswick on white birch and yellow birch, infesting an average of 35% of white birch at 19 locations; the highest count of 92% of white birch infested was at Point Lepreau, Saint John Co. In Nova Scotia, infestation levels varied on beech and white birch, averaging 36% at 7 locations; the highest count of 76% of beech infested was at Corberrie, Digby Co. No reports from Prince Edward Island.
Weevil damage *Strophosoma melanogrammum* Forst.	Balsam fir Black spruce Red maple Red pine Red spruce White birch	Nova Scotia	No damage found in the red pine plantation in Cape Breton Co., Nova Scotia, where severe defoliation occurred on 2-0 seedlings in May 1988, the first time economically significant damage was caused by this general feeder. Weevils found on a variety of hosts in widespread areas but no damage observed.
Whitemarked tussock moth *Orgyia leucostigma* (J.E. Smith)	Hardwoods	Maritime provinces	Populations generally low throughout the Maritimes, only light defoliation occurred in a few isolated areas.
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	Maritime provinces	Present throughout the Region; 28% of trees affected at St. Margarets, Northumberland Co., N.B., with an average of 11% of trees infected at eight locations in New Brunswick.
White pine cone beetle *Conophthorus coniperda* (Sz.)	Red pine White pine	Maritime provinces	No reports in 1989.
White pine sawfly *Neodiprion pinetum* Nort.	White pine	Maritime provinces	Populations low throughout; light defoliation occurred on a few plantation trees in Prince Co., Prince Edward Island.
White pine weevil *Pissodes strobi* (Peck)	Black spruce Red spruce White pine	Maritime provinces	Present throughout the Region. In New Brunswick an average of 10% of white pine damaged (15 locations, highest, 36%, at Leighton Brook, Northumberland Co.); in Nova Scotia, an average of 12% of white pine trees infested (25 locations, highest, 28%, at Jeremy's Bay in Kejimkujik National Park, Queens Co.); in Prince Edward Island 20% of white pine infested in the Auburn Woodlot, Queens Co.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Whitespotted sawyer beetle *Monochamus scutellatus* (Say)	Balsam fir Black spruce Red spruce White pine White spruce	Maritime provinces	Common throughout the Region. In New Brunswick an average of 10% balsam fir infested (18 locations, highest, 28%, at Innishannon, Gloucester Co.); in Nova Scotia 22% of white spruce infested at Swallow Hill, Cumberland Co., and 76% of balsam fir trees had damaged branches from adult feeding at Diligent River, Cumberland Co.; in Prince Edward island, 40% of balsam fir trees infested near Lorne Valley, Kings Co. and in the Brookdale Demonstration Woodlot, Queens Co.
Willow blight *Venturia saliciperda* Nuesch	Willow	Maritime provinces	Light shoot and foliage browning at scattered locations in Kent, Restigouche and Westmorland counties, New Brunswick; moderate browning on ornamentals at Lyons Brook, Pictou Co., Nova Scotia; and light shoot damage in Kings Co., Prince Edward Island.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Balsam poplar Willow	Maritime provinces	Severe and moderate leaf browning of willow in southeastern New Brunswick, throughout Nova Scotia, and much of Prince Edward Island.
Wind damage	Conifers Hardwoods	Maritime provinces	Trace to light damage scattered throughout the Region. A small, violent windstorm in early July in Carlisle, Carleton Co., New Brunswick blew down trees and damaged property. In Nova Scotia, extensive foliage damage and browning occurred on Cape Breton Island and on the northern mainland (see text). In Prince Edward Island, wind-damaged hardwood foliage common throughout, at St. Teresa, Kings Co. 45% sugar maple foliage on 60% of trees affected.
Winter drying	Conifers	Maritime provinces	In New Brunswick, light and moderate foliage discolouration common on Scots pine Christmas tree plantations in Madawaska and Victoria counties. In Nova Scotia, foliage discolouration severe on red pine at Pleasant Harbour, Halifax Co., and moderate on black spruce at Maggie Brook, Victoria Co., trace and light damage common elsewhere in both provinces. No reports from Prince Edward Island.
Winter moth *Operophtera brumata* (L.)	Apple Red oak	Maritime provinces	Moderate and light defoliation in an old apple orchard at New Minas, Kings Co., present on ornamental trees at Truro, Colchester Co., Nova Scotia, and a few larvae found on red oak at Milton, Queens Co., Prince Edward Island. Numerous moths observed in October and November at Truro, Colchester Co., Stellarton, Pictou Co., and Guysborough Interval, Guysborough Co. No reports from New Brunswick.

Maritimes Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Witches' broom of balsam fir *Melampsorella caryophllacearum* Schroet.	Balsam fir	Maritime provinces	Widespread in New Brunswick but not common or numerous at any particular location. Present on scattered trees at 33 locations in 13 counties in Nova Scotia. In Prince Edward Island, an average of 14% of trees had brooms (five locations), 28% of the trees with brooms at Brookvale, Queens Co.
Witches' broom of spruce *Chrysomyxa arctostaphyli* Diet.	Black spruce	Maritime provinces	No reports in 1989.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce Red spruce White spruce	Maritime provinces	In New Brunswick, severe or moderate defoliation of a few trees in a black spruce plantation at Londonderry, Kings Co.; only light defoliation at Lisson Settlement, Kings County, where moderate defoliation occurred in 1988. In Nova Scotia, defoliation severe on a single tree at Lewis Lake, Halifax Co., and moderate on a few trees at Yankeetown, Halifax Co. On Prince Edward Island, severe or moderate defoliation of 20% of black spruce in a 2-ha plantation at Conway, Prince Co.

Québec Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Amber-marked birch leafminer *Profenusa thomsoni* (Konow)	White birch	Outaouais	Light to trace levels of damage.
Anthracnose *Discula* sp.	Sugar maple	Sainte-Félicité (Matane)	Foliage disease severely affected three of sugar maple in 1988. In 1989, disease present but did not cause damage.
	Sugar maple and basswood	South of Montréal	Generalized occurrence.
Aspen serpentine leafminer *Phyllocnistis populiella* (Cham.)	Trembling aspen	Throughout Gaspé	The intensity of the damage varies from light to moderate throughout the area.
		Throughout the North Shore region	The intensity of the damage varies from light to moderate.
Birch casebearer *Coleophora serratella* (L.)	White birch	Lower St. Lawrence	Increase in the intensity of damage. Moderate defoliation.
		Area from Grande-Vallée to Gaspé	Light to moderate infestation.
		Sainte-Marthe-de-Gaspé, Rivière-la-Madeleine, along Road 198 midway between Anse-Pleureuse and Murdochville	Severe damage.
		Saguenay River valley from Alma to Chicoutimi, the townships of La Baie, Ferland and Boilleau, and Rivière-Éternité to Baie-Sainte-Catherine	Increase in the area infested; moderate damage.
		Vicinity of La Tuque	Light to moderate infestation.
Cedar leafminers *Argyresthia* spp. *Coleotechnites thujaella* (Kft.)	Eastern white cedar	Eastern Townships	No damage but presence observed.
		South of Montréal	Severe damage.
		Along Lake Memphrémagog	Decline in the infestation compared with last year.
Cone diseases *Baeospora myosura* (Fr.) Singer	Norway spruce	Sainte-Foy (Québec)	First mention on this host in Canada.
Rutstroemia bulgaroides (Raben.) Karsten	Norway spruce	Berthierville (Berthier and Valcartier (Québec)	First mention on this host in Québec. However, it was collected in the field in 1987, but not identified at that time.
	Blue spruce	Ancienne-Lorette (Québec)	First mention on this host in Québec. Discovered in 1987, but not identified.
Deer damage	White pine	Gatineau	Forest where white pines were outplanted under a cover of hardwoods was moderately damaged.
Drought	White birch and other hardwoods	South of Montréal	Hardwoods growing in rocky soil and in mountainous areas affected by drought.
Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau	White elm	Pointe Navarre (Gaspé)	Rapid progression of the disease on this site discovered in 1988.
		L'Anse-Saint-Jean (Chicoutimi)	Disease spread in this area.
Early birch leaf edgeminer *Messa nana* (Klug)	White birch	Outaouais	Light to trace levels of damage.

Québec Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Elm lace bug *Corythuha ulmi* O. & D.	White elm Basswood	Between Brennan's Hill and Old Chelsea, along Road 105 (Gatineau)	Light damage.
European snout beetle *Phyllobius oblongus* (L.)	Sugar maple Norway maple	Nicolet vicinity	Present at trace levels in nine maple stands.
Fall cankerworm *Alsophila pometaria* (Harr.)	Red maple	Champlain (Champlain)	Reduction of the infestation in these pockets compared with recent years.
	Silver maple	Lac Saint-Pierre (Berthier)	
Fomes root rot *Heterobasidion annosum* (Fr.) Bref (= *Fomes annosus* (Fr.) Karst.)	Red pine	Lac la Blanche (Papineau) north of Thurso.	First time detected and first mention in Québec. Carpophores of the fungus were found in September 1989 on about 10 trees that had died the year before in a plantation of over 25 ha, approximately 50 years old, and in which thinning was carried out about 10 years ago.
Gray willow leaf beetle *Pyrrhalta decora decora* (Say)	Willow, poplar	Administrative region of Abitibi-Témiscamingue	The trees affected are 100% defoliated.
Greenstriped maple worm *Dryocampa rubicunda rubicunda* (F.)	Red maple	Princeville (Arthabaska)	Trace levels.
	Sugar mpale	Trois-Rivières region	Trace levels.
Hail damage	Balsam fir	Lake Drolet and Gould (Frontenac)	On June 18, 1989, a severe hailstorm caused considerable damage to two plantations of Christmas tree plantations. The non-lignified branches suffered substantial damage, resulting in heavy losses for producers.
	Hardwoods and conifers	Rivière Coigny (Abitibi)	On July 5, 1989, a hailstorm resulted in the defolaition of hardwoods and the uprooting of conifers over a 2 x 10-km area 2 km north of Rivière Coigny, on the Matagami road.
Imported willow leaf beetle *Plagiodera vericolora* (Laich.)	Willow	Parc des Laurentides Rivière Chicoutimi sector	Defoliation of 75 to 100% of trees over a distance of 5 km.
Ink spot *Ciborinia whetzellii* (Seav.) Seav.	Trembling aspen	Baie-Trinité West and Lac Caster (Saguenay)	Sites with low rate of infection.
Jack pine sawfly *Neodiprion pratti banksianae* Roh.	Pitch pine	Pitch pine Ecological Reserve (south of Montréal)	6% of trees affected at trace levels.
Larch casebearer *Coleophora laricella* (Hbn.)	Tamarack	Cap-Chat	70 000 trees affected over 50% of the tree.
		Eastern Townships	Very high incidence.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Tamarack	North Shore region	Increasingly marked presence.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Québec City, North Shore and Lower St. Lawrence - Gaspé regions	Near Clermont (Charlevoix-East) moderate defoliation over 2 300 ha and severe defolation over 2 725 ha. Near the Manic II reservoir (Saguenay), light damage over 1 700 ha and moderate damage over 1 175 ha. Near St-Bruno (Kamouraska), moderate damage over 1 175 ha and severe damage over 700 ha.
Leaf blister *Taphrina dearnessii* Jenkins	Red maple	Saint-Paul-d'Abbotsford south of Montréal	A number of ornamental and forest red maples affected.

Québec Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Maple leaf cutter *Paraclemensia acerifoliella* (Fitch)	Sugar maple	Southern Québec, vicinity of Cowansville, Sutton, and Knowlton	Light damage over approximately 800 ha. Several local infestations near Lachute (47% defoliation) and Drummondville (69%).
Maple leaf roller *Sparganothis acerivorana* Mack.	Sugar maple	Beauce	Moderate defoliation.
Maple webworm *Tetralopha asperatella* (Clem.)	Sugar maple	From Lachute (Argenteuil) to Saint-Gabriel (Labelle)	14 sites observed where defoliation varied from trace to moderate.
		Buckingham (Papineau)	Defoliation estimated at 10%.
Needlecast *Naemacyclus minor* Butin	Scots pine	Les Méchins (Matane)	A number of trees have lost approximately 50% of their total foliage.
Needle rust *Coleosporium asterum* (Diet.) Syd.	Red pine	Kingsley Falls (Drummond)	100% of the trees in this plantation affected, but only lightly.
Chrysomyxa ledicola Lagh.	Black spruce	Lac de Foin (Abitibi)	Plantation with all trees lightly affected.
	White spruce	Lac Leman and Lac Cardinal (Saguenay)	Plantations moderately affected.
Chrysomyxa ledi (Alb. & Schw.) de By.	Black spruce	Lac Patrie (Abitibi)	All trees in plantation lightly affected.
Oak leafshredder *Croesia semipurpurana* (Kft.)	Red oak	Île d'Orléans, Côte-de-Beaupré	Moderate defoliation.
		Saint-Louis-de-Champlain (Champlain)	No damage but presence noted.
Pine needleminer *Exoteleia pinifoliella* (Chamb.)	Jack pine	St-Pierre-Baptists (Mégantic)	100% of trees moderately affected.
		Ste-Cécile-de-Lévrard (Nicolet)	Pine trees lightly affected.
		Lorrainville (Témiscamingue)	All trees affected but less severely than last year.
Pine tortoise scale *Toumeyella parvicornis* (Ckll.)	Lodgepole pine	Sainte-Françoise (Lotbinière arboretum)	Severe damage causing mortality.
Pitted ambrosia beetle *Corthylus punctatissimus* (Zimm.)	Sugar maple	Saint-Cyrille (Drummond)	Very low numbers.
Porcupine damage	Scots pine	Saint-Elzéar (Bonaventure) Saint-Anselme (Dorchester)	Two Scots pine plantations had high levels of damage attributable to porcupines.
Red pine sawfly *Neodiprion nanulus nanulus* Schedl	Red pine	Pitch pine Ecological Reserve (south of Montréal)	28% of trees affected at trace levels. Down from 1988.
Root kill	Conifers seedlings	Throughout Québec, but primarily in the administrative regions of Québec City, Trois-Rivières, Montréal, and Abitibi-Témiscamingue.	Major problems in nurseries in the winter of 1988-89, particularly in containerized seedlings. In some sites, 50% of the seedlings affected and a large number killed.
Root rot *Cylindrocladium floridanum* Sob & Sey *Cylindrocarpon destructans* (Zinnssm.) Sch. *Fusarium* spp.	Conifer seedlings	In 10 provincial nurseries in Québec	Damage more serious this year than in 1988 in nurseries producing bare-rooted plants. Several seed beds with 3 to 8% plants affected.
Scleroderris canker *Gremmeniella abietina* var. *balsamea* O. Petrini et al.	White spruce	Laurentian wildlife area (Montmorency)	First report from Québec. Found in 1987 in natural regeneration. 2 to 4% trees affected.

Québec Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Spearmarked black moth *Rheumaptera hastata* (L.)	White birch	Saguenay - Lac-Saint-Jean region	Moderate to severe damage.
		Lac Malbaie (Charlevoix-Est)	Moderate defoliation.
Spruce bud midge *Rhabdophaga swainei* Felt	White spruce	Saint-Elzéar, Lac la Ferme (Bonaventure), Chandler, Grande-Rivière	Two white spruce plantations severely affected.
	Black spruce	4 km north of Saint-Elzéar	Severe infestation in this plantation.
		Grande-Rivière and Sainte-Thérèse-de-Gaspé	Moderate infestation.
Spruce spider mite *Oligonychus ununguis* (Jacobi)	Spruce Red pine	Throughout	Damage observed in five nurseries. At one location, two parcels of white spruce representing a total of 1.5 million plants were moderately affected (22% of the plants).
Strawberry root weevil *Otiorhynchus ovatus* (L.)	Conifer seedlings	Generalized in nurseries	Damage observed in 215 lots of bare-rooted plants in eight provincial nurseries. In two nurseries, the problem was more serious than in 1988. In a third nursery, larvae were found in lots of plants that had been unaffected by the insect in 1988.
Swaine's jack pine sawfly *Neodiprion swainei* Midd.	Jack pine	Saguenay - Lac-Saint-Jean	Pockets of light defoliation scattered over 2 570 ha.
		Trois-Rivières	Pockets of light defoliation scattered over 630 ha, and moderate defoliation over 71 ha at Lake Cousacouta.
		Montréal region	Light defoliation over 94 ha.
Sweet fern blister rust *Cronartium comptoniae* Arth.	Jack pine	Notre-Dame-du-Rosaire (Chicoutimi)	Natural forest has moderate infection rate.
Western gall rust *Endocronartium harknessii* (Moore) Hiratsuka	Jack pine Scots pine	Sainte-Sophie-de-Lévrard (Nicolet), Cookshire (Compton)	Two plantations affected at moderate levels.
	Jack pine	Pointe-des-Monts (Saguenay)	One plantation where the pathogen is found at high levels.
		Colombiers (Saguenay)	The disease was found at trace levels in this plantation surrounding a nursery.
		Chapais (Northern Québec)	Natural forest where the trees are lightly affected.
White pine blister rust *Cronartium ribicola* J.C. Fischer	White pine	Lac aux Orignaux (Champlain)	Increase in damage in this plantation. In 1988 damage was moderate; in 1989 it was severe.
		Ayer's Cliff (Stanstead), Petit lac Groulx (U.G. Témiscamingue)	Natural white pine forests with moderate rates of infection.
Willow leaf miner *Lyonetia* sp.	Balsam poplar	Area located between Rivière-Sainte-Marguerite and Rivière-Portneuf (Saguenay)	Severe damage.

Québec Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Wind damage	Hardwoods and conifers	Saint-Léon-de-Standon (Dorchester)	On October 16, a tornado uprooted trees over an area of 30 ha.
	Sugar maple and Eastern white pine	Saint-Victor (Beauce)	A small tornado struck five hectares of sugar maple stands and one hectare of an Eastern white pine stand over 100 years old.
	Jack pine and black spruce	Lac Normand (Champlain)	A snow storm and high winds in late October 1988 affected a number of sectors of the forest over a total area of 409 hectares.
Winter drying	Conifers	Throughout	Winter drying observed in spring 1989 throughout province. Roadside conifer stands particularly affected.
	Hardwoods	Québec City region	Hardwoods along Highway 20, from Québec City to Montmagny, and along Highway 73, from Québec City to Saint-Lambert, were affected by drying to varying degrees ranging from light to severe.
Wood stain *Dothiorina tulasnei* (Sacc.) Hoehnel	Beech	Saint-Ubald (Portneuf)	First report from Québec; discovered in 1987.
	Pin cherry	Lake Sergent (Portneuf)	First mention in Québec, but discovered there in 1987.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce White spruce Norway spruce	Gaspé	Insect present throughout the peninsula but damage light. Of the 250 spruce plantations visited, 138 were damaged (65 black spruce, 71 white spruce, and 2 Norway spruce).
Yellow witches' broom *Melampsorella caryophyllacearum* Schroet.	Balsam fir	Saint-Théophile (Beauce)	Plantation of Christmas trees moderately affected.

Ontario Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Alder flea beetle *Artica ambiens* (LeC.)	Alder	Chapleau, Kirkland Lake, and Timmins districts	Heavy infestations with defoliation up to 100% at scattered locations.
American aspen beetle *Gonioctena americana* (Schaeff.)	Trembling aspen	Northern Region	Defoliation in Gogama and southern Chapleau districts was approximately 90%. Light damage common in Timmins, Temagami, and Kirkland Lake districts.
Anthracnose *Aureobasidium apocryptum* (Ell. & Ev.) Hermanides-Nijhof	Sugar maple	Sault Ste. Marie District	Foliar damage of 80% reported on roadside trees in VanKoughnet Township.
Discula platani (Peck) Sacc.	Sycamore	Southwestern Region	Varying levels (20-85%) of leaf infection on ornamentals in the districts of Wingham, Simcoe, Chatham, and Aylmer.
Armillaria root rot *Armillaria ostoyae* (Romagnin.) Herink	Pine	Northeastern Region	A 10 ha plantation in Labonte Township, Wawa District had 7.3% of the 1.7-m trees infected. A 4 ha progeny test with 3.3% infected trees occurred in Smilsky Township, Sault Ste. Marie District.
	Jack pine	North Central Region	Mortality levels of 15-20% reported in a 2 ha plantation of 1.5-m trees in Ashmore Township, Geraldton District. A similar 2 ha plantation nearby was reported to have 5% mortality.
Aspen leafblotch miner *Phyllonorycter ontario* Free.	Trembling aspen	Northwestern Region	Widespread medium to heavy infestations caused >75% foliar damage to fringe and understorey trees in Ignace, Red Lake, and Sioux Lookout districts.
		North Central Region	Pockets of moderate to severe foliar damage recorded.
Aspen webworm *Tetralopha aplastella* (Hlst.)	Trembling aspen	Chapleau, Kirkland Lake, Timmins, and Blind River districts	Common. The heaviest damage occurred in Meen Township, Blind River District, where 50% defoliation of semimature trees was observed.
Balsam fir sawfly *Neodiprion abietis* complex	Balsam fir	Carleton Place District	Caused 10-25% foliar damage to scattered trees in Fitzroy, Beckwith, and Drummond townships. Elsewhere, populations declined.
Bark beetles *Hylurgops pinifex* Fitch *Ips pini* (Say) *Pityogenes hopkinsi* Swaine *Trypodendron rufitarsus* (Kby.)	Pines	Algonquin and Eastern regions	Small pockets of drought stressed trees varying in size from 1 to 80 trees were attacked across both regions.
Beech scale *Cryptococcus fagisuga* Linding	Beech	Central Region	New infestations discovered at Sibbald Point Provincial Park, Maple District, and in Short Hills Provincial Park, Niagara District.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Southern Ontario	Populations lower than usual with the exception of the Eastern Region, where severe browning of roadside and ornamental trees was reported.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Northern Ontario	Heaviest damage to forest trees in Temagami District, where defoliation in the 80-100% range was encountered in a number of small stands in six townships in the northern part of the district. Numerous other areas of damage reported on both ornamentals and forest trees.
Black army cutworm *Actebia fennica* (Tausch.)	Spruce Pine	Thunder Bay Forest Nursery	Eight pheromone traps captured 183 adult male moths. No significant damage observed in the nursery.
	Spruce	Hearst, Kapuskasing, and Cochrane districts	Two pheromone traps, in each of four prescribed burns, captured 48, 42, 36, and 12 male moths, respectively. No evidence of damage observed.
Blackheaded jack pine sawfly *Neodiprion pratti banksianae* Roh.	Jack pine	Northern Ontario	Defoliation as high as 60% was reported near French Lake, Atikokan District. Foliar damage of up to 10% occurred in the Thunder Bay and Cochrane districts.
Bruce spanworm *Operophtera bruceata* (Hlst)	Sugar maple Beech	Eastern Region	A further reduction in population of this pest recorded, with only trace defoliation to regeneration near the town of Clayton, Carleton Place District.
		North Central Region	Populations have declined drastically this year in the Thunder Bay District. The total area of moderate-to-severe defoliation decreased to 54 335 ha. There were pockets of 60-70% foliar damage but damage ranging from 20-50% defoliation was most common. Trace population levels observed in Pic Township, Terrace Bay District.
Cedar browning	Eastern white cedar	Lindsay District and Eastern Region	This condition was evident through the entire area. Possible causes include drought, a heavy cone crop, winter drying and the cedar leaf miner.
Cedar leafminers *Argyresthia aureoargentella* Brower, *A. canadensis* Free., *A. thuiella* (Pack.), and *Coletechnites thujaella* (Kft.)	Eastern white cedar	Eastern Region	Sporadic moderate to severe damage throughout the Brockville, Cornwall, and Carleton Place districts.
		Algonquin Region	Foliar damage as high as 65% in several townships in the Pembroke and Bancroft districts.
		Southwestern Region	Populations declined to low levels in most areas.
		Central Region	Defoliation ranging from 10 to 40% persisted in Medonte, Tay, and Flos townships, Huronia District and in Haldimand Township, Lindsay District.
Cherry casebearer *Coleophora pruniella* Clem.		Napanee District Cornwall District	High numbers evident in Sandbanks Provincial Park, Napanee District and Carillon Provincial Park, Cornwall District.
Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau	Elm	Chatham District	Mortality of 6% and incidence of 9% recorded on roadside trees in Raleigh Township.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Early aspen leafcurler *Pseudexentera oregonana* (Wlsm.)	Trembling aspen	Red Lake District	High populations caused 22 655 ha of moderate to severe defolation.
		Hearst District	Surveys disclosed 15 703 ha of moderate to severe defoliation.
		Nipigon District	Approximately 1 600 ha of moderate defoliation.
		Wingham District	A small 1.5 ha pocket of defoliation.
Early birch leaf edgeminer *Messa nana* Klug	White birch	Sudbury District	Light defoliation in McKim and Neelon townships.
Eastern pine shoot borer *Eucosma gloriola* Heinr.	Jack pine	Northern Ontario	Leader damage ranging from 10 to 20% on regeneration in Atikokan, Thunder Bay, Kirkland Lake, Timmins, Chapleau, and Sudbury districts.
	White pine	Minden District	Seed orchard trees in Snowden Township sustained 12.7% leader damage.
Eastern tent caterpillar *Malacosoma americanum* F.	Apple Cherry Birch	Eastern, Algonquin, Central, and Northeastern Regions	Severe defoliation in the Eastern Region and the southern portion of the Central Region. Light defoliation in the northern portion of the Central Region and the Algonquin and Northeastern regions.
Elm leafminer *Fenusa ulmi* Sund.	Elm	Eastern Region	Scattered single trees suffered upwards to 100% foliar damage.
Elm spanworm *Ennomos subsignaria* (Hbn.)	Sugar maple	Pembroke District	Roadside trees at one location sustained 10% defoliation.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Scots pine Red pine	Eastern Region	Both hosts defoliated (10-50%) at a number of locations in Napanee, Brockville, Carleton Place, and Tweed districts.
		Simcoe District	Defoliation averaged 30% but ranged as high as 90% on Scots pine Christmas trees in Charlotteville Township.
		Central Region	General population increase.
European pine shoot moth *Rhyacionia buoliana* (D. & S.)	Scots pine	Southwestern Region	Surveys revealed increased populations, and 80% leader damage was reported in one Christmas tree plantation in Simcoe District.
	Mugho pine	Napanee District	A light infestation reported in Tyendinaga Township.
Eutypella canker *Eutypella parasitica* Davidson & Lorenz	Sugar maple	Bracebridge District	A high of 8% infection occurred in a natural stand in Wood Township.
Fall cankerworm *Alsophila pometaria* (Harr.)	Manitoba maple	Sioux Lookout District	Ornamental Manitoba maple in Sioux Lookout sustained defoliation ranging from 40 to 90%.
Fall webworm *Hyphantria cunea* (Drury)	Hardwoods	Eastern Region	Caused up to 90% defoliation of individual and small groups of trees in Brockville and Napanee districts.
		Aylmer, Niagara, and Simcoe districts	Increased population caused defoliation ranging from 10 to 50% to forest edge and roadside trees.
		Northern Region	80% defoliation to willow and alder in southern Kirkland Lake District.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Fir broom rust *Melampsorella caryophyllacearum* Schröter	Balsam fir	Nipigon District	Found infecting 10% of the balsam fir trees in a stand near Waweig Lake.
Fire blight *Erwinia amylovora* (Burr.) Winslow et al.	Mountain-ash	Kapuskasing District	Individual trees had 20% foliar damage in Casselman Township.
Fireweed rust *Pucciniastrum epilobii* Otth	Balsam fir Fireweed	Chapleau District	Foliar damage of 15% occurred on 100% of the examined trees in Panet Township.
Fir-willow rust *Melampsora abieticapraearum* Tubeuf	Balsam fir	Chapleau District	Foliar damage of 15% was reported on 100% of the regeneration in Floranna Township.
Frost damage	Balsam fir and spruces	North Central and Northwestern Region	Sporadic light damage in a few areas in the Nipigon, Thunder Bay, Atikokan, Fort Frances, and Ignace districts.
Gray willow leaf beetle *Tricholochmaea decora*	Willow	Northern Region	Moderate to severe defoliation throughout the region.
Greenstriped mapleworm *Dryocampa rubicunda* (F.)	Red maple	Atikokan District	Defoliation of 70-80% in the Turtle Lake-Finlayson Lake area.
Hackberry nipplegall maker *Pachypsylla celtidismamma* (Riley)	Hackberry	Chatham District	High populations on the lower portion of trees on Sheridan Point, Pelee Island.
Hemlock-poplar rust *Melampsora abietiscanadensis* C.A. Ludwig ex Arthur	Hemlock	Aylmer District	This disease damaged 60% of cones in a 10-ha woodlot in Dereham Township.
Horse chestnut leaf blotch *Phyllosticta sphaeropsoidea* Ell. & Ev.	Horse chestnut	Niagara and Simcoe districts	Host trees experienced 95 to 100% foliar damage.
Hypoxylon canker *Hypoxylon mammatum* (Wahlenb.) J. Miller	Trembling aspen	Espanola and Sudbury districts	High infection levels caused 30% mortality in a small trembling aspen stand in Dowling township, Sudbury District. Infection levels of 2 to 5% were common in stands in northern Espanola and Sudbury districts.
Imported willow leaf beetle *Plagiodera versicolora* (Laich.)	Willow	Carleton Place District	One hundred percent of the foliage on streambank trees in Murphy's Point Provincial Park was damaged.
Ink spot of aspen *Ciborinia whetzelii* (Seaver) Seaver	Trembling aspen	North Central Region	Reduction of infestation levels in the eastern half of the region. Small pockets of heavy damage scattered through Nipigon and Thunder Bay districts.
		Hearst, Kapuskasing, Cochrane, and Sudbury districts	Heavy infections of this disease in a number of areas in all four districts.
Introduced pine sawfly *Diprion similis* (Htg.)	Red pine	Atikokan District	Small numbers collected in Atikokan, a new distribution record for this insect.
Ironwood leafblotch miner *Cameraria ostryarella* (Cham.)	Ironwood	Carleton Place District	Regeneration suffered an average of 50% foliar damage.
Jack pine sawfly *Neodiprion pratti paradoxicus* Ross	Jack pine	Eastern Region	Damage levels ranging from 10-80% occurred in several plantations and on ornamentals.
Jack pine tip beetle *Conophthorus banksianae* McP.	Jack pine	Chapleau, Gogama, and Blind River districts	Populations decreased across these areas; 23.3% of the shoots affected in Timbrell Township, Blind River District, compared with 68% in 1988.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Larch casebearer *Coleophora laricella* (Hbn.)	Tamarack European larch	Northeastern Region	50% defoliation in a 20-ha stand of tamarack in Pedley township, North Bay District.
		Algonquin Region	Defoliation ranged from 10 to 40% in Bancroft, Bracebridge, Minden, and Parry Sound districts.
		Central Region	Foliar damage in the 80-100% range occurred in Erin Township, Cambridge District, at Orono Forest Station, Lindsay District, and along the Niagara Parkway in Niagara District.
		Southwestern Region	Defoliation of 80-100% occurred in Charlotteville and South Walsingham townships, Simcoe District and Osprey Township, Owen Sound District.
		Eastern Region	80% defoliation in a 2.5-ha plantation in South Plantagenet Township, Cornwall District.
Larch-poplar rust *Melampsora medusae* Thüm	Hybrid poplar	Kapuskasing District	Foliar damage as high as 95% was reported at the Bonner Center in Farquhar Township.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Larch	Hearst, Kirkland Lake, and Temagami districts.	Light defoliation at widely scattered locations.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Terrace Bay District	Light defoliation along the Trans-Canada Highway between Hay Lake and the Aguasabon River.
Leaf blight *Septoria betulae* Pass.	White birch	Terrace Bay District	Infection levels declined considerably. Moderate to severe damage covered 15 240 ha in the south-central portion of the district.
		Espanola and Sudbury districts	Moderate damage to regeneration throughout the northern portion of both districts.
Leaf scorch	Sugar maple	Southwestern and Central regions	Varyng levels recorded on roadside trees, with up to 100% of the foliage affected at some locations.
Leaf spot *Tubakia dryina* (Sacc.) B. Sutton	Oak	Simcoe District	Complete defoliation occurred to several trees in the town of Norwich in North Norwich Township.
Lesser birch casebearer *Coleophora comptoniella* (McD.)	White birch	North Bay District	Defoliation in the 10-20% range recorded in areas 0.5 ha in size in Bertram and Falconer townships.
Linden looper *Erannis tiliaria* (Harr.)	Hardwoods	Terrace Bay District	Populations declined. Defoliation averaged 30% in the southern portion of the district with a total of 23 285 ha affected.
Little spruce sawfly *Pristiphora lena* Kinc.	White spruce	Chapleau District	A few colonies caused 10% defoliation to open grown trees, Shoals Provincial Park.
Maple bladdergall mite *Vasates quadripes* Shimer	Silver maple	Chapleau District	Complete foliar damage to ornamentals in the town of Chapleau.
Maple leafblotch miner *Cameraria aceriella* (Clem.)	Red maple Sugar maple	Espanola District	Heavy damage in two small stands, one at Fort LaCloche and one in Billings township.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Maple leafcutter *Paraclemensia acerifoliella* (Fitch)	Sugar maple	Carleton Place District	Foliar damage of 25% occurred on 20% of host trees at Murphy's Point Provincial Park.
		Napanee District	A 2-ha stand sustained 80% defoliation and roadside trees averaged 30% defoliation in Hallowell Township.
Maple trumpet skeletonizer *Epinotia aceriella* (Clem.)	Sugar maple	Napanee District	Foliar damage averaged 60% on 90% of the trees in a 25-ha stand in Presquile Provincial Park, Napanee District. Sixty percent of the trees in a 20-ha stand in Hallowell Township, Napanee District sustained 60% foliar damage.
Maple webworm *Tetralopha asperatella* (Clem.)	Sugar maple	Owen Sound District	High populations in stands hosting medium to heavy infestations of forest tent caterpillar.
		Huronia and Lindsay districts	Low numbers.
Mortality of balsam fir	Balsam fir White spruce	Blind River, Sault Ste. Marie, and Wawa districts	Widespread mortality of balsam fir, usually single or small groups of trees (up to five trees) as well as the occasional white spruce was reported. Affected trees were in stands previously subjected to medium to heavy infestations of spruce budworm. Some trees showed no obvious cause of death while in other samples a number of associated pests were found: the balsam fir bark beetle *Pityokteines sparsus* Lec. was found on some balsam fir, the spruce beetle *Dendroctonus rufipennis* Ky. on some white spruce. Sawyer beetles and Armillaria root rot were also recovered from a number of trees.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain-ash	Northwestern and North Central regions	Population levels remained generally low. Noteworthy exceptions were in the communities of Ear Falls, Red Lake District, Sioux Lookout, Sioux Lookout District and Murillo, Thunder Bay District where 75 to 90% defoliation was recorded.
		Chapleau and Gogama	Open grown trees in Ivanhoe Provincial Park, Chapleau District sustained 60% defoliation and similar damage levels were recorded in Dublin Township, Gogama District.
		Northeastern Region	Numerous trees sustained 50 to 100% defoliation in Wishart Township, Sault Ste. Marie District, and Peterson Township, Wawa District.
Needle blight *Rhizosphaera kalkhoffii* Bubak	Black spruce	Nipigon District	Surveys revealed 5% foliar damage to 8% and 26% of the trees at two locations near Limestone Lake.
Needle cast *Meloderma desmazierii* (Duby) Darker	Scots pine	Wingham District	Defoliation averaged 75% on approximately 7% of the trees in a small plantation in Turnberry Township.
Needle rust *Chrysomyxa ledi* (Alb. & Schw.)	Spruce	North Central Region	Numerous plantations and natural stands sustained 100% infection levels with 20-70% defoliation in Thunder Bay, Atikokan, and Geraldton districts.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Northern Region	Widespread infection reported across the region. The incidence of attack was often 100% in these areas but actual foliar damage was usually in the 20 to 25% range.
		Northeastern Region	Low levels of damage recorded in Striker Township, Blind River District.
Northern pine weevil *Pissodes approximatus* Hopk.	White pine	North Bay and Espanola districts	Mortality of 1-2% observed in young 1-2 m plantations in Antoine Township, North Bay District and Tennyson Township, Espanola District.
Northern tent caterpillar *Malacosoma californicum pluviale* (Dyar)	Trembling aspen, willow, white birch, and cherry	Chapleau and Nipigon districts	High population levels on shrubbery and on small trees in Pattinson, Floranna, and Lipsett townships, Chapleau District and in Elmhirst Township, Nipigon District.
Oak leaf shredder *Croesia semipurpurana* (Kft.)	Oak	Niagara, Chatham, and North Bay districts	Defoliation rates of 1-5% reported from a few stands.
		Blind River District	Area forecasted to have damage was heavily infested with forest tent caterpillar.
Pale tussock moth *Halysiodota tessellaris* (J.E. Smith)	Basswood	Chatham District	In Sombra Township 20% of the trees at a roadside improvement site sustained 100% defoliation.
Pine false webworm *Acantholyda erythrocephala* (L.)	Pines	Eastern Region	Defoliation averaged 60% on 100% of the 2-m trees in a 1-ha plantation in Fitzroy Township, Carleton Place District. Elsewhere single webs were common throughout the region.
		Algonquin and Central regions	Varying and sometimes high populations observed at numerous locations in both regions.
Pine needleminer *Exoteleia pinifoliella* (Cham.)	Jack pine	Espanola, Sudbury, and North Bay districts	Mature trees over 130 ha sustained damage on 80% of the old foliage in Bigwood Township, Sudbury District. Defoliation of 50% was recorded in a 2-ha stand in Curtin township, Espanola District, and in a 5-ha stand in McPherson Township, North Bay District.
Pine needle rust *Coleosporium asterum* (Dietel) Sydow	Jack pine	Chapleau and Gogama districts	Incidence of 90-99% was recorded on regeneration in several areas with actual foliage damage ranging from 20-65%.
		Thunder Bay and Atikokan districts	Three areas with 10-15% foliar damage were recorded.
Pine needle scale *Chionaspis pinifoliae*	Scots pine	Niagara District	High numbers in an 18-ha plantation in Wainfleet Township.
Pine needle sheathminer *Zelleria haimbachi* Bsk.	Jack pine	Napanee District	Caused 40% and 78% defoliation at plantations in Ernestown Township.
Pine tortoise scale *Youmeyella parvicornis* (Ckll.)	Jack pine	Northern and North Central regions	Sporadic, small medium to heavy infestations reported.
	Jack pine	Ignace and Red Lake districts	Low numbers occurred at several locations.
Physiological needle drop	White pine	Aylmer, Chatham, Niagara, and Simcoe districts	Incidence of attack ranged from 31% to 89%, with associated foliar damage of 5% to 65%.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Pitted ambrosia beetle *Corthylus punctatissimus* (Zimm.)	Sugar maple	Brockville District	Mortality of 56% of 0.5-m regeneration at one location in North Burgess Township.
		Espanola District	Severe infestations and related mortality observed in Allan Township.
		Huronia and Maple districts	Approximately 10% tree mortality at a number of locations.
Readheaded jack pine sawfly *Neodiprion virginiana* complex	Jack pine	Northern Ontario	Heaviest damage in Alcona Township, Chapleau District where defoliation averaged 35%. Lighter defoliation reported in Nipigon, Thunder Bay, Geraldton, Kirkland Lake, Sudbury, and Hearst districts.
Readheaded pine sawfly *Neodirpion lecontei* (Fitch)	Red pine	Algonquin Region	Infestations with average defoliation of 10-14% occurred in several areas. Sporadic tree mortality recorded in Minden and Parry Sound districts.
		Northeastern Region	Populations increased in Espanola, Sudbury, and North Bay districts. Tree mortality reported in a 30-ha plantation in Olrig Township, North Bay District.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	Temagami District	Heavy infestations on shoreline and island stands on Lake Temagami.
Red pine sawfly *Neodiprion nanulus nanulus* Schedl.	Red pine Jack pine	Northern Ontario	Light damage levels at numerous points across the north.
Root rot *Cylindrocladium floridanum* Sob. & C.P. Seym.	Seedlings	Blind River District	A light infection reported in one compartment in the Thessalon Forest Tree Nursery.
Salt damage	Pines and Eastern white cedar	Central, Algonquin, and Northeastern regions	Trees along major highways damaged.
Satin moth *Leucoma salicis* (L.)	Silver poplar	Carleton Place, Napanee, and Tweed districts	Increased populations causing moderate to severe damage at scattered locations.
Septoria canker *Septoria musiva* Peck	Hybrid poplar	Eastern Region	Mortality of 1% in 10 000 hybrid poplar stems in a 1-ha area on Highway 42 south of Westport, Brockville District.
Septoria leaf spot *Mycosphaerella populicola* G.E. Thompson	Balsam poplar	Ignace, Red Lake, and Sioux Lookout districts	Widespread damage ranging from 5 to 90% encountered at numerous locations.
Solitary oak leafminer *Cameraria hamadryadella* (Clem.)	Red oak	Espanola District	Moderate defoliation over a 0.5 ha area of 15-m trees, Mills Township.
Speckled tar spot *Rhytisma punctatum* (Pers.) Fr.	Sugar maple	Wingham District	Caused complete leaf infection and defoliation in a 5-ha area in Stephens Township.
Spruce cone rust *Chryosmyxa pirolata* (Körn.) Winter	Spruce	North Central Region	At the Thunder Bay Forest Nursery 10% of the cone crop on 1.5-m grafted stock infected.
		Northeastern Region	A 0.5-ha plantation of 15-m trees received 2-5% damage to 100% of its cone crop in Robinson Township, Espanola District. Low levels of infection reported in Allen Township, Espanola District and Gurd Township, North Bay District.
Spruce coneworm *Dioryctria reniculelloides* Mut .& Mun.	White spruce Black spruce	North Central Region	Relatively high numbers of this coneworm occurred at Eye Lake, Atikokan District and in Blackwell Township, Thunder Bay District.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Central and Northwestern regions	Light infestations occurred in Bexley Township, Lindsay District and in Sioux Lookout District.
Spruce spider mite *Oligonychus ununguis* (Jac.)	Eastern white cedar	Lindsay District and Eastern Region	Associated with cedar browning at numerous locations.
	White spruce	Fort Frances District	Moderate to severe damage to hedges in the town of Stratton.
Sugar maple borer *Glycobius speciosus* Say	Sugar maple	Algonquin and Central regions	The number of trees attacked ranged from 4 to 24% in Minden, Bracebridge, Parry Sound, and Lindsay districts.
Swaine jack pine sawfly *Neodiprion swainei* Midd.	Jack pine	Temagami District	Light defoliation recurred over a 200-ha area of Trethewey Township and dead tops have started to appear in this area. Moderate to severe defoliation on Island 127 in Lake Temagami.
Sweetfern blister rust *Cronartium comptoniae* Arthur	Jack pine	Atikokan District	A survey near Spratt Lake in a 14-ha plantation disclosed an infection rate of 8%.
		Chapleau District	An infection rate of 5% in a 10-ha plantation in de Gaulle Township.
		Ignace District	Infection rate of 6% at a semipermanent plot on the Sowden Lake road.
Tar spot needle cast *Davisomycella ampla* (J. Davis) Darker	Jack pine	Chapleau and Gogama districts	Severe damage at scattered points in both districts. In a 5-ha plantation in Nimitz Township, Chapleau District, 90% of the trees were affected with 25% foliar damage.
Twig pruner *Haphidionoides* sp.	Red oak	Bracebridge and Parry Sound districts	Light infestations in Medora Township, Bracebridge District, and Carling Township, Parry Sound District.
Twoleaf tier *Psilocorsis cryptolechiella* (Cham.)	Red oak	Espanola District	Light to moderate defoliation over a 5-ha area of mature oak at Fort LaCloche.
Variable caterpillar *Pyrrhia experimens* (Wlk.)	Ground plants	Hearst District	The previous infestation collapsed but high numbers in a nearby newly planted area.
Walnut caterpillar *Datana integerrima* G. & R.	Black walnut Butternut	Southwestern Region and Central Region	Scattered individual trees averaging 7.8 m in height sustained 50 to 100% defoliation throughout Aylmer, Simcoe, and Niagara districts.
Warren's root collar weevil *Hylobius warreni* Wood	Scots pine	North Bay District	Mortality of 3% in grafted trees of a seed orchard in Gurd Township.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirats.	Jack pine	Northern Ontario	The incidence of attack ranged as high as 57%, with corresponding main stem attack as high as 42%. Overall, at 26 areas surveyed, the incidence of attack averaged 18% and stems attacked averaged 10%.
White pine blister rust *Cronartium ribicola* J.C. Fischer	White pine	Eastern, Algonquin, and Central regions	Evaluations disclosed 0 to 20% infection levels at widely scattered locations across southern Ontario. Noteworthy damage was reported in Rawdon Township, Tweed District, Ross Township, Pembroke District, and in Douro Township, Lindsay District.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Northern and Northeastern regions	Infection levels ranged from 3 to 26% in northern Ontario. Some of the affected areas were in Kosny Township, Chapleau District, and Antoine Township, North Bay District.
White pine weevil *Pissodes strobi* (Peck)	Pines and spruces	Southern Ontario	Damage generally light. Highest damage occurred in Ross Township, Pembroke District, where 27% of the trees were affected.
		Northeastern Region	General population increase. Highest level of damage was in Hurlburt Township, Sault Ste. Marie District, where 25% of the jack pine was damaged.
		Northern Region	Low levels of damage common with occasional severe damage. In Charters Township, Kirkland Lake District, 26% of the jack pine were attacked.
		North Central Region	Significant increase in population levels. Along the Camp 517 Road, Thunder Bay District, 20% of the trees in a jack pine plantation were damaged, the highest in the region.
		Northwestern Region	Low populations through the southern portion of the region.
Whitespotted sawyer beetle *Monochamus scutellatus* (Say)	Jack pine	Hearst District	High levels of damage occurred in small 0.5 to 1-ha areas of mature timber in Marjorie Township.
Willow flea weevil *Rhynchaenus rufipes* (LeC.)	Willow	Eastern Region	Complete foliar browning occurred in Silver Lake Provincial Park, Carleton Place District and Sharbot Lake Provincial Park, Tweed District.
		Huronia District	Foliar damage (50-100%) was reported at McRae Point Provincial Park.
Willow leafminer *Micurapteryx salicifoliella* (Cham.)	Willow	Northern and North Central regions	Heavy infestations reported throughout much of Cochrane, Kapuskasing, Hearst, Geraldton, Terrace Bay, and Nipigon districts.
Winter drying	Pines	Northeastern Region	Foliar browning observed at various locations across the region. Heaviest damage occurred in Bouck Township, Blind River District, where 58% of the red pine trees in a 4-ha plantation had an average of 30% foliar damage.
Woolly alder sawfly *Eriocampa ovata* (L.)	Alder	Thunder Bay District	Caused 90-100% defoliation to areas of alder in the city of Thunder Bay and in rural areas within a radius of about 30 km around the city.
Yellowheaded spruce sawfly *Pilonema alaskensis* (Roh.)	White spruce Black spruce	Napanee District	Defoliation level of 75% in a 1-ha plantation in Loughborough Township.
		Lindsay and Minden districts	The insect caused 11% defoliation in a white spruce plantation in Eldon Township, Lindsay District. Roadside trees in Snowdon Township, Minden District, sustained an average of 50% defoliation to 96% of the trees.
		Blind River, Sault Ste. Marie districts	Low populations on ornamentals in Sault Ste. Marie and near Blind River.

Ontario Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Northern Region	Average defoliation 50% on ornamentals in the villages of Foleyet and Chapleau and in Wakimi Provincial Park, Chapleau District; scattered areas of light defoliation through the remainder of the region.
		North Central Region	Several areas of moderate to severe damage in the Terrace Bay, Geraldton, Thunder Bay, and Atikokan districts, with defoliation as high as 100%.

Northwest Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Airborne pollutants	Deciduous tree species	Alberta	Symptoms of airborne pollutant damage near the oil sands plant at Fort McMurray and in the Grande Cache area.
American aspen beetle *Gonioctena americana* (Schaeff.)	Aspen Willow	Alberta Manitoba NWT	Light to moderate damage in the Northwest Angle and Duck Mountain provincial parks, in Riding Mountain and Waterton Lakes national parks, and near Kakisa Lake, NWT.
Aphids, open-feeding	Most species	Alberta NWT	Common on coniferous and deciduous hosts in most areas surveyed.
Armillaria root rot *Armillaria ostoyae* (Romag.) Herink	Many hosts	Alberta Saskatchewan Manitoba NWT	Various degrees of infection causing mortality in plantations and in natural regeneration. Some mortality noted between Hay River and Fort Smith, NWT.
Aspen and poplar leaf and twig blight *Venturia macularis* (Fr.) E. Müller & Arx *Venutia populina* (Vuill.) F.	Aspen Poplar	Alberta Saskatchewan	Frequently noted on regeneration in forested areas.
Aspen twoleaftier *Enargia decolor* (Wlk.)	Aspen	Manitoba	Light defoliation in the Nelson House region.
Aspen webworm *Tetralopha aplastella* (Hulst.)	Aspen Poplar	Saskatchewan	Common associate with forest tent caterpillar; caused scattered light to moderate defoliation in east-central Saskatchewan.
Atropellis canker of pine *Atropellis piniphila* (Weir) Lohman & Cash	Pine	Alberta Saskatchewan	Occurs throughout most of the range of lodgepole pine in Alberta, including the Cypress Hills.
Bear damage	Pine	British Columbia	Notable tree mortality along Highway 93 in Kootenay National Park.
Birch leafminers *Fenusa pusilla* (Lep.) *Profenusa thomsoni* (Konow)	Birch species	Alberta Sasktachewan	Light to moderate leaf mining damage to ornamental birch in most urban centers; moderate and severe mining in native stands (mostly by *P. thomsoni*) in Alberta and in Meadow Lake Provincial Park in Saskatchewan.
Blackknot of cherry *Apiosporina morbosa* (Schw.) Arx	Choke cherry Pin cherry May Day trees	Alberta	Common on native choke cherry and pin cherry and on May Day trees in central and southern areas.
Blowdown	Pine Spruce	Alberta Manitoba	Some scattered white spruce blowdown in the Peace River and Slave Lake forests, lodgepole pine and white spruce affected in Jasper National Park, and black spruce in two areas of Manitoba.
Blue spruce sawfly *Cephalcia fascipennis* (Cress.)	Spruce	Alberta	Several collections from the Edmonton area and a nursery near Innisfail.

Northwest Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Bruce spanworm *Operophtera bruceata* (Hulst)	Aspen	Alberta	The bruce spanworm caused significant defoliation of trembling aspen forests in many areas of southern and central Alberta. Moderate to severe defoliation occurred in the Bragg Creek area, at several scattered locations along Highway 22 between Turner Valley and Lundbreck, in the Obed area east of Hinton, north of Edson, near Marlboro, and along the Trunk Road south of Hinton. Light and moderate defoliated patches were observed in aspen stands north of Cochrane, near Sundre and Didsbury, and near Alix, Stettler, and Fabyan.
Chemical injury	Most conifers	Alberta	Improper application of herbicides, pesticides, and soil sterilants is an ever-increasing problem in many areas.
Clearwing moth *Synanthedon* sp.	Spruce Pine	Alberta Saskatchewan	Stem and branch mortality in major urban centers in Alberta. Some injury noted on mature spruce in Saskatchewan.
Comandra blister rust *Cronartium comandrae* Pk.	Pine	Manitoba	Light infections in plantation surveys in the Stead and Sandilands areas.
Cone maggot *Strobilomyia* sp.	Tamarack	Manitoba	Severe damage to cones and seeds in the Nourse area.
Conifer seedling damage	Spruce	Alberta	A few 1 + 0 bare-root seedlings in Pine Ridge Forest Nursery girdled below ground level, probably by strawberry root weevil (*Otiorhynchus ovatus* L.).
Cottonwood leafmining beetle *Zeugophora abnormis* LeConte	Poplar	NWT	Light damage on young balsam poplar near Kakisa Lake.
Dwarf mistletoe *Arceuthobium pusillum* Pk.	Spruce	Manitoba	Light infections on black spruce in Manitoba.
Early aspen leafroller *Pseudexentera oregonana* Wlsm.	Aspen	Alberta Saskatchewan Manitoba	Light to moderate leaf rolling in many areas of southern Alberta. Moderate to severe injury across central Saskatchewan and near Poplarfield and Ashern in Manitoba. Associated with forest tent caterpillar.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Spruce	Manitoba	Light defoliation in Riding Mountain National Park.
Eastern pine shoot borer *Eucosma gloriola* Heinr.	Pine	Manitoba	Light shoot damage in plantations in southeastern Manitoba.
Excessive needle drop	Pine Spruce	Alberta	Extensive natural pruning reported in the province, probably accentuated by a severe frost that occurred in early fall.
Fall cankerworm *Alsophila pometaria* (Harr.)	Elm Green ash Manitoba maple	Alberta Saskatchewan Manitoba	Light to severe defoliation in most urban centers in Saskatchewan, Manitoba, and southern Alberta.
False tinder conk *Phellinus tremulae* (bond.) Bond. & Boriss.	Aspen	Manitoba	Light infection noted in plantations.
Fir coneworm *Dioryctria abietivorella* (Grt.)	Pine Spruce	Alberta	Light occurrence in central Alberta; common in Pine Ridge Forest Nursery.
Fire blight *Erwinia amylovora* (Burr.) Winsl. et al.	Apple Mountain-ash	Alberta Saskatchewan Manitoba	Scattered light infections.

Northwest Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Frost injury (late spring)	Spruce	Alberta Saskatchewan	Light to moderate bud and shoot damage in several plantations in both provinces.
Gray willow leaf beetle *Tricholochmaea decora* (Say)	Willow species	Alberta Saskatchewan	Considerable leaf skeletonizing of the foliage of willow species in several areas in west-central Alberta: west of Rocky Mountain House, along Highway 16 between Evansburg and Jasper, at several locations along Highway 43 between Gunn and Valleyview, north of Valleyview to Guy, and in the Peace River and Manning areas. In Saskatchewan, scattered pockets of moderate to severe skeletonizing of willow species reported throughout the east-central part of the province.
Grieving woodling *Egira deolosa* (Grt.)	Aspen	Manitoba	Light to moderate defoliation near Shergrove.
Hypoxylon canker *Hypoxylon mammatum* (Wahl.) Miller	Aspen Poplar	Alberta Saskatchewan Manitoba	Infections common throughout the central aspen forests.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Larch	NWT Alberta	In the Northwest Territories, moderate to severe defoliation in stands of eastern larch in the Fort Smith area, at several locations along Highway 1 between Enterprise and Kakisa Lake extending to the Trout River, where defoliation increased. Similar defoliation occurred throughout the Fort Simpson area, along the Mackenzie River to the North Nahanni River, and south along the Liard River to Rabbit Creek. From this point southward to the B.C. border, small pockets of light defoliation occurred in most larch stands checked. In Alberta, light defoliation in eastern larch stands west of Rocky Mountain House. Light injury also noted in Siberian larch plantings in Edmonton and Red Deer and in shelterbelts near Blackfalds and Vermilion.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Aspen	Prairie provinces	In Alberta, present in many areas and caused light to moderate defoliation between Calgary, Turner Valley, and Millarville, along Highway 22 between Lundbreck and High River, near Bragg Creek and Cremona, and in some parts of the Cypress Hills. Low populations detected at a few other scattered locations. Although generally present throughout the forest tent caterpillar outbreak area, it was not the primary defoliator. In Saskatchewan, significant defoliation in many areas where the forest tent caterpillar occurred, especially in west-central Saskatchewan and in Duck Mountain Provincial Park. Elsewhere, low populations in most aspen stands examined. In Manitoba, infestations increased causing light, moderate, and severe defoliation. Patches totalled 18 650 ha in Duck Mountain Provincial Park and Riding Mountain National Park. Low populations in most other aspen areas inspected.

Northwest Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Leaf beetles *Chrysomela* spp.	Aspen Poplar Willow	British Columbia Alberta Saskatchewan	Damage to aspen stands characterized by moderate to severe skeletonizing of leaves by the aspen leaf beetle *C. crotchi* was common in southwestern and central Alberta and central Saskatchewan. The willow and poplar leaf beetle, *C. falsa*, was responsible for leaf skeletonizing of both willow and balsam poplar in Yoho, Banff, and Jasper national parks. Light to moderate leaf injury was evident in Yoho and Banff. In the Northwest Territories, scattered pockets of light damage by *C. falsa* were reported in the following general areas: Wood Buffalo National Park, Fort Smith, Trout River, Kakisa Lake, and Fort Providence.
Leaf-folding sawfly *Phyllocolpa* nr. *agama* (Rohwer)	Poplar	Alberta	Generally light damage on poplar regeneration.
Leaf rust on aspen *Melampsora* sp.	Aspen	Alberta	Moderate to severe infections in aspen stands in central and northern Alberta.
Lodgepole needleminer *Coleotechnites starki* (Freeman)	Pine	Alberta	Low population levels in Banff National Park in the Saskatchewan Crossing and Weeping Wall area and near Mt. Norquay and Banff.
Lodgepole terminal weevil *Pissodes terminalis* Hopping	Pine	Alberta Saskatchewan	Low populations in lodgepole pine in Alberta foothills. Incidence as high as 20% in jack pine plantations in central Saskatchewan.
North American fruit lecanium *Parthenolecanium corni* (Bouché)	Manitoba maple	Saskatchewan	Light to moderate infestations in the Prince Albert area.
Northern pitch twig moth *Petrova albicapitan* (Bsk.)	Pine	Alberta Manitoba NWT	Light damage to young stands and plantations in Alberta and Manitoba and in natural regeneration in the NWT.
Northern spruce borer *Tetropium parvulum* Casey	Spruce	Alberta	Caused wormhole damage and lumber degradation to white spruce timber in northern Alberta.
Pear sawfly *Caliroa cerasi* (L.)	Cotoneaster Pin cherry Mountain-ash	Alberta	Skeletonizing common in most urban centres in the province.
Pine false webworm *Acantholyda erythrocephala* (L.)	Pine	Alberta	Defoliating Scots pine in Edmonton. New regional record.
Pine needle scale *Chionaspis pinifoliae* (Fitch)	Pine Spruce	Alberta Saskatchewan Manitoba	Light infestations on ornamentals and shelterbelt trees in central Alberta. Moderate and severe damage to spruce plantings in Maidstone and in the Caronport area in Saskatchewan. Light damage to jack pine in Spruce Woods Provincial Forest and in the Sandilands, Manitoba.
Pine tortoise scale *Toumeyella parvicornis* (Ckll.)	Pine	Manitoba	Moderate to severe damage in young pine plantations in the Sandilands area.
Poplar gall-forming mite *Aceria* nr. *dispar* (Nalepa)	Aspen	Alberta	Moderate to severe infestations in the Stettler-Castor area of east-central Alberta.

Northwest Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Poplar serpentine leafminer *Phyllocnistis populiella* Chambers	Aspen	NWT	Caused extensive leaf mining damage between Trout River and Fort Simpson and in the Fort Liard and Nahanni Butte areas. Light to moderate incidence near Fort Providence, Enterprise, and Fort Smith. A marked increase in defoliation observed from Trout River westward to the Fort Simpson, Nahanni Butte, and Fort Liard areas.
Porcupine damage	Conifers	British Columbia Alberta	Scattered individual tree mortality in shelterbelt and ornamental plantings in central and southern Alberta; scattered lodgepole pine mortality in Yoho National Park.
Powderpost beetle *Ptilinus lobatus* Csy.	Spruce	Alberta	This is the first known record of this anobiid beetle species causing structural damage to spruce timbers.
Powdery mildew *Uncinula salicis* (DC. ex Mérat) Wint.	Aspen	Alberta Manitoba	Light to moderate incidence scattered throughout the aspen parkland zone in Alberta and on saplings in Duck Mountain Provincial Park, Manitoba.
Red belt	Alpine fir	Alberta	Injuries evident along west-facing slopes of the Endless Chain Mountain Range in Jasper National Park.
Rusty tussock moth *Orgyia antiqua* (Linnaeus)	Pine Caragana	Alberta	Severe defoliation to caragana in Grande Prairie.
Salt damage	Pine	Alberta	Road salts used for de-icing caused tree mortality in many areas of the province.
Spruce beetle *Dendroctonus rufipennis* (Kby.)	Spruce	Alberta	Severe attack to a single tree in Sir Winston Churchill Provincial Park. Endemic populations in central, western, and northwestern Alberta.
Spruce bud midge *Rhabdophaga swainei* Felt	Spruce	Alberta	Terminal bud damage common in plantations and in natural regeneration in central Alberta.
Spruce gall aphid *Adelges cooleyi* (Gill.)	Spruce	Alberta Saskatchewan Manitoba NWT	Light to moderate throughout the region.
Spruce needle rust *Chrysomyxa ledicola* Lagh.	Spruce	British Columbia Alberta Saskatchewan NWT	Moderate to severe infections in Kootenay National Park and along Highway 93 in Banff National Park; light infections along Highway 35 north of Paddle Prairie and in Grande Prairie, Edson, and Whitecourt forests. Decreased severity noted in areas north of Paddle Prairie along Highway 35. Scattered light infections common across central Saskatchewan, moderate to severe near Little Fishing Lake. A light infection near Kakisa Lake, NWT.
Spruce spider mite *Oligonychus ununguis* (Jac.)	Spruce	Alberta Saskatchewan Manitoba	Generally light throughout the region.
Squirrel damage	Pine	Alberta Saskatchewan Manitoba NWT	Light branch flagging injury noted at several locations resulting from cone clipping.

Northwest Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Western ash bark beetle *Hylesinus californicus* (Swaine)	Mountain-ash	Alberta Saskatchewan	High level of damage noted in southern Alberta. Low populations in Saskatchewan.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Pine	Alberta Saskatchewan Manitoba NWT	Common in pine regeneration and plantations.
White pine weevil *Pissodes strobi* (Peck)	Pine Spruce	Alberta Saskatchewan Manitoba	Low to medium incidence on young spruce in Riding Mountain and Kootenay national parks and in spruce and pine plantations in western Manitoba and central and northern Albeta. Light damage common in central Saskatchewan. Severe injury evident in some private nurseries in Alberta.
Winter drying	Most species	Alberta Manitoba	Severe bud and foliage injury common in many areas in Alberta. Some injury to red pine near Falcon Lake in Manitoba.
Yellow headed spruce sawfly *Pikonema alaskensis* (Roh.)	Spruce	Prairie provinces	The yellowheaded spruce sawfly continues to be the major defoliator of white and Colorado spruce plantings in urban centers, and in shelterbelts and of regeneration white spruce at many locations. In Alberta, moderate to severe defoliation of spruce ornamentals continued to be a problem in the following urban centers: Edmonton, Red Deer, Calgary, Medicine Hat, Lethbridge, and Grande Prairie. Severe defoliation of planted white spruce occurred in the Waterton Lakes National Park townsite area and on spruce regeneration at scattered locations along the Cameron Lake and Red Rock Canyon roads. In Saskatchewan, scattered pockets of light and moderate defoliation on white spruce regeneration in Prince Albert National Park. Similar injury noted on ornamental spruce plantings and in some shelfterbelts around major urban areas. In the Northwest Territories, light defoliation of white spruce in Wood Buffalo National Park near Pine Lake in the vicinity of Enterprise, and near Kakisa Lake.
Yellow witches' broom *Chrysomyxa arctostaphyli* Diet.	Spruce	Alberta Saskatchewan Manitoba NWT	Common disease in many mature and semimature stands.

Pacific and Yukon Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Adelgids *Adelges abietis* L. *Adelges lariciatus* (Patch)	Engelmann spruce White spruce	Catleger	New distribution record.
		Dawson Creek	Old galls common at One Island Lake.
		Cassiar	Light damage common at French River.
Pineus spp.	Engelmann, Sitka, white spruce	Kamloops, Nelson, Prince George, Prince Rupert	Common; light infections.
Alder flea beetle *Altica ambiens* LeC.	Alder	West Kootenay	Skeletonizing of foliage common and widespread.
Alder leaf beetle *Pyrrhalta puntipennis* (Mannerheim)	Alder	Terrace to Prince Rupert	Light to moderate defoliation common in patches.
Alder woolly sawfly *Eriocampa ovata* (L.)	Alder	Fraser Valley, Prince Rupert, Kalen Island	Severe defoliation in widespread patches, some for the fifth year.
Ambrosia beetles *Gnathotrichus* spp.	Douglas-fir	Lillooet	Common in Douglas-fir beetle-attacked trees.
Apple and thorn skeletonizer *Choreutis pariana* (cl.)	Apple	Nelson Region	Widespread light and severe skeletonizing in West Kootenay.
Apple ermine moth *Yponomeuta malinella* Zell.	Apple Crabapple	Kamloops, Vancouver regions	Light to severe defoliation; considerable range expansion and first record in Kamloops Region.
Armillaria root rot *Armillaria ostoyae* (Romagn.) Herink	Douglas-fir Lodgepole pine	Nelson Region	Common in all age classes; infected 10-55% (avg. 28%) of trees in 23 stands.
	Engelmann spruce Alpine fir	Glacier National Park	Mature trees killed in pockets.
	Alpine fir	Valemount	20% of immature trees infected.
Armillaria sp.	Whitebark pine	Revelstoke	New host record.
Aspen leaf roller *Pseudexentera oregonana* (Wlsm.)	Trembling aspen	Greenwood	5-10% of foliage affected in patches.
Atropellis canker *Atropellis piniphila* (Weir) Lohman & Cash	Lodgepole pine	All regions	Stem infections severe in dense stands in Cariboo and Nelson regions; endemic elsewhere.
Balsam shootboring sawfly *Pleroneura* sp.	Amabilis fir	Vancouver, Nelson regions	Killed half the new shoots; a first in natural mature stands.
Balsam twig aphid *Mindarus abietinus* Koch	Amabilis fir Grand fir	Vancouver Region	Epidemic in several areas.
Balsam woolly adelgid *Adelges piceae* (Ratzeburg)	Amabilis fir	Vancouver	New distribution at China Creek and Qualicum, established in southwest British Columbia within the quarantine zone.
Bark beetles *Hylastes nigrinus* (Mannerheim)	Douglas-fir	Powell River	Girdled and killed saplings.
Pityophthorus sp.	Lodgepole pine	Prince George	New attacks on western gall rust stem infections.
Bark fungi *Amphicytostroma* sp.	Douglas-fir	Sooke	First collection in B.C.; found above galleries of an engraver beetle, *Scolytus unispinosus* LeC.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Apostrasseria sp.	Lodgepole pine Englemann spruce White sprued	Bear Lake Revelstoke Barriere	New host records.
Endothiella aggregata Funk	Western white pine	Prince George	New host record from trial area.
Birch leaf miners *Lyonetia saliciella*	White birch	Kaslo, Whatshan Lake	Light defoliation.
Lyonetia sp.		Hazelton	
Fenusa pusilla (Lepeletier)		Cariboo and Vancouver regions	Light and moderate defoliation of scattered stands.
		Terrace Yukon Territory	Range extension to the northwest.
Profenusa thompsoni (Konow)		New Hazelton, Chilliwack Revelstoke, Prince George	New distribution record. Light and moderate discolouration of roadside and city trees.
Birch skeletonizer *Bucculatrix canadensisella* Chambers	White birch	Hazelton	Discoloured 10% of the foliage at Keynton Lake.
Black stain root disease *Leptographium wageneri* (Kendr.) Wingf.	Douglas-fir	East Kootenay	Affected seed trees near Invermere, in Armillaria-infected stands north of Golden, and in 70% of trees in 3-ha patch at Skelly Creek.
Canker fungi *Cenangium ferruginosum* Fr. x Fr.	Lodgepole pine	Watson Lake	First record in Yukon. Common in study area.
Gelatinosporium griseo-lanatum Funk	Douglas-fir	Nakusp	New host record. Caused severe dieback of young trees.
Hypoxylon fuscum Pers.:Fr.	Alder	Castlegar	New host record.
Melanconis alni Tul.	Water birch	Cache Creek	New host record.
Catkin fungus *Phragmotrichum rivoclarinum* (Peyronel) Sutton & Pirozynski	Alder	Nakusp	First collection in B.C. Caused dieback associated with insect oviposition scars.
Conifer weevils *Magdalis* sp.	Lodgepole pine	Cariboo Region	Light defoliation near Takla Lake.
Scythropus californicus Schoen.	Western white pine	Texada Island, Sunshine Coast	Defoliated 5-70% of old foliage of scattered patches of immature trees.
Cooley spruce gall adelgid *Adelges cooleyi* (Gill.)	Engelmann spruce Douglas-fir	All regions	Needle discolouration common in young Douglas-fir stands and galls common on spruce.
Cypress tip moth *Argyresthia* sp.	Ornamental cypress	Victoria	Light tip mortality.
Dieback fungi *Apostrasseria* sp.	Lodgepole pine Engelmann spruce White spruce	Prince George Revelstoke Barriere	New host records; killed seedlings at Peculiar Lake.
Fusarium sp.	Cypress	Victoria	New host record. Numerous small galls on several trees.
Parvacoccum pini R.S. Hunt & A. Funk	Western white pine	Mesachie	First collection in B.C. Dieback of tips.
Phacidium gaeumannii (Miller) DiCosmo, Nag Raj & Kendrick	Amabilis fir	Sechelt	New host record.
Phoma sp.	Siberian larch	Whitehorse	First collection in the Yukon. Killing new shoots.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Sydowia semenospora Funk & Finck	Douglas-fir	Victoria	New host record. On needles.
Valsa abietis Fr.	Black spruce	Mayo	New host record. Common in Klondike Highway area.
Valsa sordida Nits.	Black cottonwood	Kitwanga	First specimen for DAVFP, Victoria. Transplanted cuttings had cankers.
Dime canker *Durandiella pseudotsugae* Funk	Douglas-fir	Nakusp, Whatshan Lake	Common on immature trees.
Dogwood leaf blight *Gloeosporium* sp.	Dogwood	Vancouver Region	Severe infections and tree mortality continue on Lower Mainland and eastern Vancouver Island.
Douglas-fir beetle *Dendroctonus pseudotsugae* Hopk.	Douglas-fir	Cariboo, Kamloops, Nelson, and Prince George regions	Increased numbers of mature trees killed, usually predisposed by maturity and recent droughts.
Douglas-fir coneworm *Dioryctria pseudotsugella* Munroe	Douglas-fir	Kamloops Region	Common in small numbers, associated with spruce budworm defoliation.
Dwarf mistletoes *Arceuthobium americanum* Nutt. ex Engelm.	Lodgepole pine	Cariboo and Prince George regions	Severe infections widespread in western and southern parts.
Arceuthobium tsugense (Rosendahl) G.N. Jones	Western hemlock	Prince Rupert and Vancouver regions	Widespread in coastal host range causing increment loss.
Elm leafminer *Agromyza aristata* Malloch	Elm	Prince George	65% of foliage infested for fourth consecutive year on city boulevards.
European leafroller *Archips rosana* (L.)	Apple Willow	Kamloops Region	Common along roadsides.
European mistletoe *Viscum album* L. ssp. *album*	Apple	Victoria	Established at four sites where first found in 1988.
Fall webworm *Hyphantria cunea* (Drury)	Deciduous trees and shrubs	Kamloops Region	Light and moderate defoliation common.
		Vancouver Region	Severe defoliation by increased populations.
False hemlock looper *Nepytia freemani* Munroe	Douglas-fir	Kamloops Region	Light defoliation expected in 1990 by increased populations.
Fir coneworm *Dioryctria abietvorella* (Grote)	Douglas-fir	Port Alberni, Sechelt	Partial gridling at base of terminal leaders on immature trees.
Fir engraver beetle *Scolytus ventralis* LeC.	Grand fir	Nelson Region	Drought-stressed trees killed in 30 patches totalling 235 ha in Pend-d'oreille Valley.
Giant conifer aphid *Cinara* sp.	Lodgepole pine White spruce	Prince Rupert Region	Lightly infested understorey pine at Dease River and spruce ovr 10 ha near Smithers.
Green velvet looper *Epirrita autumnata omissa* (Harrison)	Alpine fir	Prince Rupert	Light defoliation at two sites; larvae common elsewhere in the southeast.
Jumping gall wasp *Neuroterus saltatorius* (Edwards)	Garry oak	Vancouver Island	Severe discolouration and premature leaf fall from individual trees for third year.
Juniper rust *Gymnosporangium* sp.	Apple	Sidney	New host record. Severe on single tree; alternate host common.
Lammas growth	Lodgepole pine	Fraser Lake	Affected 5% of seedlings with multiple branches.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Larch aspen tortrix *Choristoneura conflictana* (Walker)	Trembling aspen	Yukon Territory	Defoliated 10 000 ha between Whitehorse and Takhini, up from 1000 ha in 1988.
		Prince George	Increased populations; light and moderate defoliation along Alaska Highway kms. 110 to 230 and 510 to 525.
Larch budmoth *Zeiraphera improbana* (Wlk.)	Western larch	Nelson Region	Endemic populations; trace to very light defoliation at Johnstone Creek Provincial Park and at Anarchist Mountain.
Larch canker *Potebniamyces coniferarum* (Hahn) Smerlis	Western larch Douglas-fir	Canal Flats	Infected 10% of the larch trees and 5% of the regeneration.
Larch casebearer *Coleophora laricella* (Hbn.)	Western larch	Nelson Region	Declined to endemic levels.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Ornamental	Terrace	Light and moderate defoliation continued.
		Prince George	Trace defoliation of trees in city continued.
	Tamarack	Prince Rupert Region	Light and moderate defoliation near the Yukon border.
		Yukon Territory	Populations active near Francis Lake and along Tungsten Road for third consecutive year.
	Western larch	Nelson Region	Populations declined at Granby River with trace defoliation, and collapsed in Elk River Valley.
Leaf beetle *Syneta carinata* Mann.	Lodgepole pine	Horsefly	New host record.
Leaf spots *Cristulariella depraedans* (Cooke) Hoehn.	Broadleaf maple	Egmont	New host record.
Drepanopeziza populorum (Desm.) Hoehn.	Trembling aspen	Carmacks	Collected in Yukon Territory for the first time.
Leptothyrium sp.	Alder	Port Clements	First collection in B.C.
Linospera tetraspora G.E. Thomps.	Hybrid poplar	Harrison Mills	New host record.
Mycosphaerella rubi Roark	Raspberry	Coquitlam	New host record.
Pollaccia borealis Funk	Trembling aspen	Yukon Territory and Prince Rupert Region	Extensions of known distribution range of this recently described species.
Septoria alni Sacc.	Alder	West Kootenay	Common on roadside trees.
Septoria alnifolia Ell. & Ev.	Alder	Sandspit, Sewell Inlet	New host record. Light infections common on 10% of trees.
Septoria sp.	Garry oak	Comox	New host record.
Venturia borealis sp. nov.	Trembling aspen	Victoria	First record in B.C. Associated with leaf spot. Agar culture.
Venturia populina (Vuill.) Fabric.	Hybrid poplar	Kelsey Bay	New host record.
Lodgepole needleminer *Coleotechnites milleri* (Bsk.)	Lodgepole pine	Prince Rupert Region	Light feeding in young stands in eastern part of the region.
Lodgepole pine beetle *Dendroctonus murrayanae* Hopk.	Lodgepole pine	Prince Rupert Region	Declined to endemic levels in Dease River area.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Lodgepole pine terminal weevil *Pissodes terminalis* Hopping	Lodgepole pine	Cariboo, Prince George, and Prince Rupert regions	Leader mortality in 10 stands averaged 5%, range 1 to 12%.
Maple leaf scorch (unknown cause)	Broadleaf maple	Vancouver Region	Foliar browning again severe, causing branch dieback throughout host range.
Midges			
Jack pine midge *Cecidomyia piniiopsis* (Osten Sacken)	Lodgepole pine	Prince George Region	Crooks in branches of 15 of trees at Salmon River, Nation Bay, and Hyman Creek
Cecidomyia sp.		Cariboo Region	Branch tips killed over 100 ha near Nimpo Lake.
Dasineura sp.	Black cottonwood	Coastal British Columbia Golden, Horsefly, New Hazelton, Valemount	Bud mortality common and widespread. new distribution records.
Mites *Eriophyes calaceris* (Keifer)	Douglas maple	Hazelton	Discolouration light to severe and widespread in Skeena River Valley.
Phytoptus emarginatae (Keifer)	Pin cherry	Prince George	Boulevard trees infested.
Myxomycete *Trichia decipiens* (Pers.) Macbr.	Trembling aspen	Chilanko	First collection in B.C. Most trees over 0.5 ha with red fruiting bodies.
Needle blights *Didymascella thujina* (Durand)= Maire	Western red cedar	Vancouver Region	Light to severe infections throughout host range.
Hormonema merioides Funk, Woods & Hopkinson	Western hemlock	Egmont	New host record.
Hypodermella laricis Tub.	Western larch	Kamloops and Nelson regions	Light to severe discolouration in patches throughout host range.
Lirula macrospora (Hartig) Darker	Sitka spruce	Queen Charlotte Islands	80% of trees infected for second year near Tlell and Port Clements.
Rhizosphaera pini (Corda) Maubl.	Grand fir	Aldergrove	New host record. 1- and 2-year-old needles infected on 40% of Christmas trees in plantation.
	Western hemlock	Terrace	New host record.
Scirrhia pini Funk & Parker	Western white pine	Slocan River Valley north to Revelstoke	Light to moderate discolouration of needles.
Needle casts			
Davisomycella ampla (J.J. Davis) Darker	Lodgepole pine	Nelson Region	Moderate infection of fringe trees near Champion Lakes.
		Vancouver Region	Discoloured young trees over 10 ha at Uztlius Creek.
Elytroderma deformans (Weir) Darker	Ponderosa pine	Cariboo, Kamloops, and Nelson regions	Common and widespread; perennial infections on many trees.
Lophodermella concolor (Dearn.) Darker	Lodgepole pine	Cariboo, Kamloops, Nelson, and Prince George regions	Generally light and moderate infections common in parts of most regions.
Lophodermella montivaga Petr.	Lodgepole pine	Prince Rupert	Declined in northern part of region.
		Muncho Lake	20% of year-old needles infected on all trees.
Meria laricis Vuill.	Western larch	Kamloops and Nelson regions	Infections declined to endemic.
Rhabdocline pseudotsugae Syd.	Douglas-fir	Cariboo Region	Light infections north of Williams Lake.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Needle diseases *Hendersonia pinicola* Wehm.	Lodgepole pine	Blue River McBride	Common in young plantations infected by *Lophodermella* needle cast.
Hyalodendron sp.	Lodgepole pine	Kispiox	On dead seedlings in Rhizina root disease-infected plantation.
Phaeocryptopus nudus (Peck) Petr.	Alpine fir	Prince George	Light infection on residual crop trees at Gagnon Creek.
		Yukon Territory	First record in Yukon Territory.
Sclerophoma sp.	White pine	Skimikin	Moderate infection of lower crown needles of winter-damaged seed orchard trees.
Needle rusts Fir-fireweed rust *Pucciniastrum epilobii* Otth.	Alpine fir	Cariboo, Prince George, and Prince Rupert regions	Common in pockets, infecting current year's growth.
Hemlock-willow rust *Melampsora epitea* Thuem.	Willow	Prince Rupert	Premature yellowing and leaf drop in western parts of the region.
Large-spored-spruce-Labrador-tea rust *Chysomyxa ledicola* Lagerh.	Sitka spruce	Queen Charlotte Islands and Prince Rupert Region	Light to severe infections common; 80% of trees near Tlell and Port Clements infected for second year.
	Engelmann spruce	East Kootenay	Light to moderate infections in eastern drainages.
Small-spored-spruce-Labrador-tea rust *Chrysomyxa ledi* de Bary	White spruce	Prince Rupert Region	Infections declined to very low levels in northern part of the region.
	Engelmann spruce	East Kootenay	Light to moderate infections in eastern drainages.
Spruce broom rust *Chrysomyxa arctostaphli* Diet.	Engelamnn spruce White spruce	Nelson, Prince George, Prince Rupert regions Yukon Territory	Common; perennial brooms cause growth loss.
Weir's spruce cushion rust *Chrysomyxa weirii* Jacks.	White spruce	Hazelton	Single scattered trees severely infected and needles shed prematurely.
Western pine-aster rust *Coleosporium asterum* (Diet.) Syd.	Lodgepole pine	East Kootenay and Prince George Region	Light infections in Flathead River Valley, near Jaffray, and in the Salmon River drainage.
Melampsora abieti-capraearum Tub.	Alpine fir	Purden Lake	Light infections common.
Melampsora epitea Theum.	Willow	Francois Lake	Light infections common.
Oak leaf phylloxeran *Phylloxera* sp. nr. *coccinea*	Garry oak	Vancouver Island	Severe discolouration of scattered individuals and premature leaf drop.
Pacific willow leaf beetle *Pyrrhalta decora carbo* (LeC.)	Willow	Nelson Region	Light to moderate defoliation in northern part of West Kootenay.
		Alaska Highway	Light defoliation in patches from km 110 to 190.
Phellinus root rot *Phellinus* sp.	White spruce	Hazelton	New host record. On tree infested by Warren's root collar weevil.
Pine butterfly *Neophasia menapia* Felder & Felder	Ponderosa pine	Pritchard, Okanagan Valley	Adults numerous in upper crowns; no defoliation.
Pine engraver beetle *Ips pini* (Say)	Lodgepole pine	West Kootenay Mt. Robson Park	In conjunction with mountain pine beetle; occasionally causing tree mortality in Boundary District.
Pine flower sawfly *Xyela* sp.	Lodgepole pine	Prince Rupert Region	Common on staminate cones in young stands in eastern part of region.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Pine needle sheathminer *Zelleria haimbachi* Bsk.	Lodgepole pine	Kamloops Region	Increased populations moderately defoliated new shoots in 33 patches totalling 7525 ha in the Adams, Barriere, and Shuswap lakes areas.
		Nelson Region	Three patches totalling 415 ha defoliated in third year of infestation near Grand Forks.
		Vancouver Region	Light defoliation for fourth year near Pemberton; new infestation near Boston Bar.
Pine sawfly *Neodiprion nanulus contortae* Ross	Lodgepole pine	Yale	Severe defoliation in plantation over 15 ha.
Pine stem rusts *Cronartium coleosporioides* Arth.	Lodgepole pine	Cariboo Region	Infections widespread in host range in western and southern parts of the region.
		Nelson Region	Light infections near Castlegar and Christina Lake.
		Prince George	Light infections common in southern part of the region.
Cronartium comandrae Peck	Lodgepole pine	Prince George and Prince Rupert regions	Light infections common in scattered stands.
Poplar-and-willow-borer *Cryptorhynchus lapathi* (L.)	Willow Poplar Birch	Prince Rupert Region	Increased populations killed numerous shoots and stems.
		Kamloops Region	Common in Pritchard area.
		Vancouver Region	Tree mortality widespread.
Poplar leafrolling sawfly *Phyllocolpa* sp.	Black cottonwood	Bowron River drainage	Rolled half the foliage on most trees over 5 ha near Tumuch Lake.
Poplar shoot blights *Venturia macularis* (Fr.) E. Muell. & Arx	Trembling aspen	Prince Rupert Region	Light infections common.
Venturia populina (Vuill.) Fabric.	Black cottonwood	Prince Rupert Region	Light infections in western part of the region.
		Nelson Region	Endemic, very light scattered infections.
Redstriped needle worm *Epinotia radicana* (Heinrich)	White spruce	McGregor	Buds below snow line mined on 10% of the saplings over 100 ha at Kettle Creek.
Rhizina root disease *Rhizina undulata* Fr.	Western red cedar	Hazelton	New host record. Killed 2% seedlings in small patches.
Root fungus *Cylindrocarpon didymum* (Hart.) Wollenw.	White spruce	Kispiox River Valley	Fruiting on rotted rootlets of seedlings killed by Rhizina root disease at two sites.
Saprophytic fungus *Cladosporium* sp.	Western red cedar	Surrey	New host record. On pruned seedlings in nursery.
Satin moth *Leucoma salicis* (L.)	Poplar	Chilliwack	Light defoliation over 25 ha.
	Deciduous species	Clearwater	Adults and egg masses collected but no defoliation apparent.
Scleroderris canker *Gremmeniella abietina* (Lagerb.) Morelet	Pines	All regions	Not detected in native pines in British Columbia even at four previously positive locations.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Seedling blight *Truncatella truncata* (Lev.) Steyaert	European white birch	Whitehorse	First collection in Yukon. Causing extensive dieback and collar rot.
	Lodgepole pine	Vavenby	New host record but very few trees affected.
Silverspotted tiger moth *Lophocampa argentata* (Pack.)	Douglas-fir	Vancouver Island	Single colonies at widespread locations.
Snow mound *Herpotrichia* sp.	Engelmann spruce	East Kootenay	Killed top half of crown on 18% of seedlings.
Spotted tussock moth *Lophocampa maculata agassizii* (Pack.)	Willow	Liard Highway	Light defoliation.
Spruce aphid *Elatobium abietinum* (Wlk.)	Sitka spruce	Vancouver Region	Endemic on coastal trees.
	Ornamental spruce	Vancouver	Common in urban areas.
Spruce budmoth *Zeiraphera* sp.	White spruce	Prince George	Common but light in new shoots.
Spruce twig aphid *Mindarus obliquus* (Cholodk.)	White spruce	Heffley Creek	Infested 60% of shoots on all seed orchard trees.
Tar spot *Rhytisma salicinum* (Pers.) Fr.	Willow	Hazelton	Infected 40% of foliage on all trees at Keynton Lake.
Tip blights *Delphinella* spp.	Alpine fir	Kamloops Region	Infected 30% of foliage on young trees in northern part of host range.
Lachnellula calyciformis (Willd. ex Fr.) Dharne	White pine	Barriere	New host record.
Potebniamyces sp.	Alpine fir	Crooked River	Infection in 20% of foliage on all trees from Summit to McLeod Lake.
Sirococcus strobilinus Preuss	Western hemlock	Vancouver Region	Infected 20% of the shoots of 20% of immature trees near Vancouver and Mission.
Tomentosus root rot *Inonotus tomentosus* (Fr.) Gilbn.	Engelmann spruce	Barriere	Increased numbers with widely scattered foci.
		Nelson Region	Infected 61% of the mature trees in 10 stands.
	White spruce	Prince George	Widespread in mature stands.
	Lodgepole pine	Nelson Region	Infected 64% of the mature trees in 11 stands.
Twig beetles *Pityophthorus* sp.	Douglas-fir	Clinton	Branch tips killed at Loon Lake.
Twig blights *Ascocalyx* sp.	Siberian larch	Fort Nelson	New host record. Mortality and dieback of tops in Svenska plots.
Didymella sp.			Associated with *Ascocalyx* blight.
	White spruce	Surrey	New host record.
Ugly nest caterpillar *Archips cerasivorana* (Fitch)	Balsam poplar	Chetwynd	Severe defoliation of roadside trees along Hart Highway.
Warren's root collar weevil *Hylobius warreni* Wood	Lodgepole pine	Interior regions, particularly eastern part of Prince Rupert Region	Common in young plantations; usually less than 1% mortality annually.

Pacific and Yukon Region (cont'd)

Insects, Disease, or Damage	Host(s)	Location	Remarks
Western balsam bark beetle *Dryocoetes confusus* Swaine	Alpine fir	Cariboo, Kamloops, Prince George, Prince Rupert regions	Common, widespread mortality of mature high-elevation trees.
		Vancouver Region	Increased tree mortality.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Lodgepole pine	All regions	Common throughout host range on branches and stems; tree mortality usually less than 1%.
Western hemlock looper *Lambdina fiscellaria lugubrosa* (Hulst)	Western hemlock	Kamloops, Nelson, Prince Rupert regions	Increasing populations; no defoliation.
Western pine beetle *Dendroctr nus brevicornis* LeC.	Ponderosa pine	West Kootenay	Scattered tree mortality in Boundary and Arrow districts for third year.
Western pine shoot borer *Eucosma sonomana* Kft.	Ponderosa pine	West Kootenay	Twig dieback common between Grand Forks and Christina Lake for second year.
Western winter moth *Erannis tiliaria vancouverensis* Hulst	Maple Birch	Vancouver Region	Increased populations; widespread severe defoliation in Fraser River drainage.
Winter moth *Operophtera brumata* (L.)	Birch Fruit trees	Richmond, Delta	Moderate and severe defoliation for first time.
		Vancouver Island	Endemic populations following release of parasites from 1979 to 1981.

Selected Bibliography

The following list includes selected reports and publications produced in 1989 by the staff of Forestry Canada. Copies may be obtained from the originating forestry centre.

Forestry Canada - Newfoundland and Labrador Region

P.O. Box 6028, Bldg. 304
Pleasantville
St. John's, Newfoundland
A1C 5X8

Carew, G.C. 1989. A new needle blight disease of eastern white cedar in Newfoundland. Forestry Canada, Newfoundland and Labrador Region, Woody Points 18(1):9-10.

Clarke, L.J.; Carew, G.C. 1988. Forest insect and disease conditions in Newfoundland and Labrador in 1988. Pages 34-46 *in* Ann. Rep. Newfoundland Forest Protection Assn., For. Can. Report. For. Can., St. John's.

Clarke, L.J.; Carew, G.C. 1989. Forest insect and disease conditions in Newfoundland and Labrador in 1988. Forestry Canada, Newfoundland and Labrador Region. Inf. Rep. N-X-268.

Clarke, L.J.; Carew, G.C. 1989. Forecast of forest insect and disease conditions in Newfoundland and Labrador in 1989. Forestry Canada, Newfoundland and Labrador Region. Woody Points 18(1):2-5.

Clarke, L.J.; Carew, G.C. 1989. Forest insect and disease conditions in Newfoundland and Labrador in 1989. Mid-season report. For. Can., Newfoundland and Labrador Region. Woody Points 18(2):2-4.

Clarke, L.J.; Carew, G.C. 1989. Forest insect and disease conditions in Newfoundland and Labrador in 1989. Forestry Canada, Newfoundland and Labrador Region. Woody Points 18(3):6-10.

Hudak, J.; Warren, G.R.; Carew, G.C. 1989. The scleroderris canker in Newfoundland in 1989. Report, 17th Ann. Forest Pest Control Forum, Ottawa, 14-16 November 1989. For. Can., Newfoundland and Labrador Region, St. John's.

Singh, P.; Carew, G.C. 1989. Impact of dwarf mistletoe in black spruce forests of Newfoundland. Eur. J. For. Path. 19(5-6):305-322.

Forestry Canada - Maritimes Region

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Cormier, J.R. 1989. Forest insects and diseases in Kouchibouguac National Park in 1988. For. Can.-Maritimes Technical Note 207.

Cox, R.M.; Magasi, L.P.; Spavold-Tims, J. 1989. Deterioration of coastal white birches in relation to their chemical and physical climate. Pages 243-250 *in* Man and his Ecosystem, Vol. 2. Proc. 8th World Clean Air Congress, The Hague, 11-15 Sept. 1989.

Doane, A.S. 1989. Forest insects and diseases in Kejimkujik National Park in 1988. For. Can.-Maritimes Tech. Note 204.

Dobson, C.M.B. 1989. Forest insects and diseases in Prince Edward Island National Park in 1988. For. Can.-Maritimes Tech. Note 203.

Harrison, K.J. 1989. Understanding abiotic problems in managed stands and plantations. For. Can.-Maritimes Tech. Note No. 208.

Harrison, K.J. 1989. Ornamental trees and abiotic injury; a guide for the tree owner. For. Can.-Maritimes Tech. Note 209.

Leckie, D.G.; Ostaff, D.P.; Teillet, P.M.; Fedosejevs, G. 1989. Spectral characteristics of tree components of balsam fir and spruce damaged by spruce budworm. For. Sci. 35:582-600.

MacLean, D.A. 1988. Effects of spruce budworm outbreaks on vegetation, structure, and succession of balsam fir forests on Cape Breton Island, Canada. Pages 253-261 *in* Werger, M.J.A., et al., eds. Plant form and vegetation structure. SPB Academic Publishing, The Hague, The Netherlands.

MacLean, D.A.; Ostaff, D.P. 1989. Patterns of mortality caused by an uncontrolled spruce budworm outbreak on Cape Breton Island, Nova Scotia. Can. J. For. Res. 19:1087-1095.

Magasi, L.P. 1989. Forest pest conditions in the Maritimes in 1988. For. Can.-Maritimes Inf. Rep. M-X-174.

Magasi, L.P. 1989. White birch deterioration in the Bay of Fundy Region, New Brunswick 1979-1988. For. Can.-Maritimes Inf. Rep. M-X-175.

Magasi, L.P. 1989. Highlights of forest pest conditions in the Maritimes in mid-June 1989. For. Can.-Maritimes Tech. Note 217.

Magasi, L.P. 1989. Highlights of forest pest conditions in the Maritimes at the end of June 1989. For. Can.-Maritimes Tech. Note 218.

Magasi, L.P. 1989. Highlights of forest pest conditions in the Maritimes at the end of July 1989. For. Can.-Maritimes Tech. Note 220.

Magasi, L.P. 1989. Highlights of forest pest conditions in the Maritimes in mid-September 1989. For. Can.-Maritimes Tech. Note 221.

Magasi, L.P. 1989. Monitoring programs associated with other environmental issues in the Region: Forestry. Pages 63-77 *in* Proc. Intern. Joint Comm., Air Quality Advisory Board, First regional workshop on Integrated Transboundary Monitoring. St. Andrews, New Brunswick, 31 May-2 June, 1988.

Magasi, L.P. 1989. Maritimes Region ARNEWS Plots. *In* D'Eon, S.P.; Power, J.M. 1989. The acid rain national early warning system (ARNEWS) plot network. For. Can. Inf. Rep. PI-X-91.

Magasi, L.P.; Simpson, R.A.; Jones, A.M. 1989. Multi-agency plantation pest surveys in New Brunswick in 1988. For. Can.-Maritimes Tech. Note 210.

Magasi, L.P.; Simpson, R.A.; Jones, A.M. 1989. Multi-agency plantation pest surveys in Nova Scotia in 1988. For. Can.-Maritimes Tech. Note 211.

Meikle, O.A. 1989. Forest insects and diseases in Fundy National Park in 1988. For. Can.-Maritimes Tech. Note 206.

Ostaff, D.P.; MacLean, D.A. 1989. Spruce budworm populations, defoliation, and change in stand condition during an uncontrolled spruce budworm outbreak on Cape Breton Island, Nova Scotia. Can. J. For. Res. 19:1077-1086.

Quinn, J.P.; Pendrel, B.A.; Stewart, J.V.; Murray, T. 1989. Controlling the seedling debarking weevil: an economic analysis. For. Can.-Maritimes Tech. Note 202.

Renault, T.R.; Embree, D.G. 1989. Control of mound ants in plantations. For. Can.-Maritimes Tech. Note 219.

Walsh, T. 1989. Forest insects and diseases in Cape Breton Highlands National Park in 1988. For. Can.-Maritimes Tech. Note 205.

Forestry Canada - Québec Region

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Bordeleau, C.; Guérin, D.; Innes, L.; Lachance, D.; Picher, R. 1989. Insectes et maladies des arbres au Québec 1988. Supp. Forêt Conservation 56(1).

Desrochers, P.; Ouellette, G.B. 1988. Inhibition *in vitro* d'*Ophiostoma ulmi* par un champignon deutéromycète. Nat. can. 115:169-172.

Desrochers, P.; Ouellette, G.B.; Thibault, J.-R. 1989. Colorations, nécroses et microflore autour des blessures d'injection de thiabendazole dans l'orme. Phytoprotection 70:85-96.

Jobin, L.J.; Coulombe, C. 1988. Le piège à insectes Multi-Pher. For. Can. Région du Québec. Feuillet d'information CFL-24.

Jobin, L.J.; Coulombe, C. 1988. The Multi-Pher insect trap. For. Can. Québec Region. Information leaflet LFC-24E.

Juneau, A. 1989. Revue des opérations techniques de pulvérisations aériennes contre la tordeuse des bourgeons de l'épinette dans les forêts privées de l'est

du Québec. Forêts Canada, Région du Québec.

Juneau, A. 1989. A review of aerial spraying technology for spruce budworm control in private woodlots in eastern Quebec. Forestry Canada, Quebec Region.

Lavallée, A. 1989. Note sur la réduction de la déformation des tiges de pin blanc attaquées par le charançon du pin blanc. Phytoprotection 70:25-28.

Lavallée, R.; Morissette, J. 1989. Le contrôle mécanique du charançon du pin blanc. For. Can. Région du Québec. Feuillet d'information CFL-25.

Lavallée, R.; Morissette, J. 1989. Mechanical control of white pine weevil. For. Can. Quebec Region. Information leaflet LFC-25E.

Maltais, J.; Régnière, J.; Cloutier, C.; Hébert, C.; Perry, D.F. 1989. Seasonal biology of *Meteorus trachynotus* Vier. (Hymenoptera: Braconidae) and of its overwintering host (*Choristoneura rosaceana* (Harr.) (Lepidoptera: Tortricidae). Can. Ent. 121:745-756.

Perry, D.F.; Fleming, R.A. 1989. The timing of *Erynia radicans* resting spore germination in relation to mycosis of *Choristoneura fumiferana*. Can. J. Bot. 67:1657-1663.

Perry, D.F.; Fleming, R.A. 1989. *Erynia crustosa* zygospore germination. Mycologia 81:154-158.

Petrini, O.; Petrini, L.E.; Laflamme, G.; Ouellette, G.D. 1989. Taxonomic position of *Gremmeniella abietina* and related species: a reappraisal. Can. J. Bot. 67:2805-2814.

Régnière, J.; Turgeon, J.J. 1989. Temperature-dependant development of *Zeiraphra canadensis* and simulation of its phenology. Entomol. exp. appl. 50:185-193.

Régnière, J.; Lysyk, T.J.; Auger, M. 1989. Population density estimation of spruce budworm, *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae) on balsam fir and white spruce from 45 cm mid-crown branch tips. Can. Entomol. 121:267-281.

Rioux, D.; Ouellette, G.B. 1988. Quelques changements histologiques chez trois essences forestières inoculées avec *Ophiostoma ulmi*, pathogène de la maladie hollandaise de l'orme. Nat. can. 115:173-178.

Rioux, D.; Ouellette, G.B. 1989. Light microscope observations of histological changes induced by *Ophiostoma ulmi* in various nonhost trees and shrubs. Can. J. Bot. 67:2335-2351.

Valéro, J.R. 1989. Résultats de trois années d'applications aériennes expérimentales de *Bacillus thuringiensis* à raison de 2,0 L/ha contre *Choristoneura fumiferana* C. / Results of three years of experimental aerial application of *Bacillus thuringiensis* at 2.0 L/ha against *Choristoneura fumiferana* C. Rapp. Information LAU-X-89.

Valéro, J.R.; Letarte, R. 1989. Diagnostic biochimique de la présence d'une intoxication par *Bacillis thuringiensis* sérotype (H3a, 3b) chez deux lépidoptères. J. can. microbiol. 35:444-449.

Forestry Canada - Ontario Region

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Basham, J.T. 1988. Decay and stain 10 years later in aspen suckers subjected to scarification at age 3. Can. J. For. Res. 18:1507-1521.

Biggs, W.D.; Sajan, R.J.; Brodersen, H. 1989. Results of forest insect and disease surveys in the Central Region of Ontario, 1988. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 85.

Brodersen, H.; Biggs, W.D. 1989. Results of forest insect and disease surveys in the Southwestern Region of Ontario, 1988. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 88.

Churcher, J.J.; Howse, G.M. 1989. Another outbreak of forest tent caterpillars. OMNR - Forestry Canada Joint Report.

Constable, D.C.; Ingram, W.A.; MacLeod, L.S.; Melbourne, S. 1989. Results of forest

insect and disease surveys in the Northeastern Region of Ontario, 1988. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. 86.

Dumas, M.; Takai, S.; Richards, W.; Gross, H.L. 1989. Pathology Research in Ontario Region. Pages 3-6 *in* Plexman, C.A. ed. Forestry Newsletter. Summer Issue. For. Can.-Ont. Region, Sault Ste. Marie.

Evans, H.J.; Melbourne, S. 1989. Results of forest insect and disease surveys in the North Central Region of Ontario, 1988. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 83.

Howse, G.M.; Applejohn, M.J. 1989. Survey Bulletin; spring, summer, fall issues. For. Can.-Ont. Region, Sault Ste. Marie.

Jones, C.G.; Czerwinski, E.J. 1989. Results of forest insect and disease surveys in the Northwestern Region of Ontario, 1988. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 87.

Kaupp, W.J.; Cunningham, J.C.; Meating, J.H.; Howse, G.M.; Denys, A. 1988. Aerial spray trials with disparvirus in Ontario in 1986. For. Can. Inf. Rep. FPM-X-82.

Keizer, A. 1989. Results of forest insect and disease surveys in the Eastern Region of Ontario, 1988. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 89.

Lin, D.; Dumas, M.T.; Hubbes, M. 1989. Isozyme and general protein patterns of *Armillaria* sp. collected from the boreal mixedwood forest of Ontario. Can. J. Bot. 67:1143-1147.

Lysyk, T.J. 1989. A multiple-cohort model for simulating jack pine budworm (Lepidoptera: Tortricidae) development under variable temperature conditions. Can. Ent. 121:373-387.

Lysyk, T.J. 1989. Stochastic model of eastern spruce budworm (Lepidoptera: Tortricidae) phenology on white spruce and balsam fir. J. Econ. Entomol. 82:1161-1168.

MacLeod, L.S.; Jansons, V.; Payne, S. 1989. Results of forest insect and disease surveys in the Northern Region of Ontario, 1988. For. Can., Ont. Reg., Sault Ste. Marie. Misc. Rep. No. 82.

Myren, D.T.; Davis, C.N. 1989. Index of hosts and associated fungi identified by the Forest Insect and Disease Survey in Ontario from 1967 to 1987. I. The pines. For. Can.-Ont. Region, Sault Ste. Marie. Inf. Rep. O-X-395.

Nealis, V. 1988. Weather and the ecology of *Apanteles fumiferanae* Vier. (Hymenoptera: Branconidae). Mem. Ent. Soc. Can. 146:57-70.

Nealis, V.G.; Lysyk, T. 1989. Sampling overwintering jack pine budworm, *Choristoneura pinus pinus* Free. (Lepidoptera: Tortricidae), and two of its parasitoids (Hymenoptera). Can. Ent. 120:1101-1111.

Nealis, V.G.; Wallace, D.R. 1988. A biological control program for gypsy moth in Ontario. Pages 7-9 *in* Plexman, C.A., ed. Forestry Newsletter, summer issue. For. Can.-Ont. Region, Sault Ste. Marie.

Sajan, R.J.; Smith, E. 1989. Results of forest insect and disease surveys in the Algonquin Region of Ontario, 1988. For. Can., Ont. Region, Sault Ste. Marie. Misc. Rep. No. 84.

Thomson, M.J.; MacLeod, L.S.; Evans, H.J.; Constable, D.C.; Jones, C.G. 1988. A review of important forest insect and disease problems in the Dryden District of Ontario, 1950-1980. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 62.

Thomson, M.J.; MacLeod, L.S.; Evans, H.J.; Constable, D.C.; Jones, C.G. 1988. A review of important forest insect and disease problems in the Kenora District of Ontario, 1950-1980. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 63.

Thomson, M.J.; MacLeod, L.S.; Evans, H.J.; Constable, D.C.; Jones, C.G. 1988. A review of important forest insect and disease problems in the Ignace District of Ontario, 1950-1980. For. Can.-Ont. Region, Sault Ste. Marie. Misc. Rep. No. 64.

van Frankenhuyzen, K.; Howard, C.; Churcher, J.J.; Howse, G.M.; Lawrence, H.D. 1989. Deposition and efficacy of Dipel 8AF applied diluted and undiluted against the gypsy moth in Southern Ontario. For. Can. Inf. Rep. FPM-X-84.

Wallace, D.R. 1988. Forest entomology research: an update. Pages 3-7 *in* Plexman, C.A., ed., Forestry Newsletter, winter issue. For. Can.-Ont. Region, Sault Ste. Marie.

Wallace, D.R. 1989. Entomology rearing and quarantine facilities. Pages 5-7 *in* Plexman, C.A., ed., Forestry Newsletter, spring issue. For. Can.-Ont. Region, Sault Ste. Marie.

Whitney, R.D. 1989. The status of forest mycorrhizae technology in Ontario and Manitoba. Pages 27-30 *in* Lalonde, M., Piche, Y., eds. Canadian Workshop on Mycorrhizae in Forestry.

Whitney, R.D. 1989. Root rot damage in naturally regenerated stands of spruce and balsam fir in Ontario. Can. J. For. Res. 19:295-308.

Whitney, R.D.; Ip, D. 1988. Effects of simulated acid rain on field-grown balsam fir in Ontario. Pages 7-8 *in* Plexman, C.A., ed. Forestry Newsletter, fall issue. For. Can.-Ont. Region, Sault Ste. Marie.

Forestry Canada - Northwest Region
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Amirault, P.A. 1989. The cone and seed insects of tamarack in eastern North America. Pages 35-41 *in* Miller, G.E., compiler. Proc. Cone Seed Insects Work. Party Conf., IUFRO Working Party S2.07-01, June 26-30, 1988. For. Can.-Pacific and Yukon Region, Victoria, British Columbia.

Blenis, P.V.; Mugala, M.S.; Hiratsuka, Y. 1989. Soil affects Armillaria root rot of lodgepole pine. Can. J. For. Res. 19:1638-1641.

Cerezke, H.F. 1989. Mountain pine beetle aggregation semiochemical use in Alberta and Saskatchewan, 1983-1987. Pages 108-113 *in* G.E. Amman, compiler. Proc. Symp. management of lodgepole pine to minimize losses due to the mountain pine beetle. Kalispell, MT, July 12-14, 1988. Intermt. Res. Stn., Ogden, Utah. Gen. Tech. Rep. INT-262.

Cerezke, H.F.; Emond, F.J. 1989. Forest insect and disease conditions in Alberta, Saskatchewan, Manitoba, and the Northwest Territories in 1987. For. Can., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-300.

Chang, K.-F.; Blenis, P.V.; Hiratsuka, Y. 1989. Mechanism and pattern of spore release by *Endocronartium harknessii*. Can. J. Bot. 67:104-111.

Drouin, J.A. 1989. Herbicide efficacy trials in Alberta and Manitoba, 1980-85. For. Can., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-306.

Emond, F.J.; Cerezke, H.F. 1989. Forest insect and disease conditions in Alberta, Saskatchewan, Manitoba, and the Northwest Territories in 1988 and predictions for 1989. For. Can., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-303.

Hopkin, A.A.; Blenis, P.V.; Hiratsuka, Y. 1989. Resistance responses in juvenile seedlings of *Pinus densiflora* (Japanese red pine) inoculated with *Endocronartium harknessii*. Can. J. Bot. 67:3545-3552.

Hopkin, A.A.; Mallett, K.I.; Blenis, P.V. 1989. The use of L-DOPA to enhance visualization of the "black line" between species of the *Armillaria mellea* complex. Can. J. Bot. 67:15-17.

Langor, D.W. 1989. The western ash bark beetle. Prairie Landscape Magazine. 12(4):8.

Langor, D.W. 1989. Host effects on the phenology, development, and mortality of field populations of the mountain pine beetle *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae). Can. Entomol. 121:149-157.

Langor, D.W.; Raske, A.G. 1989. A history of the eastern larch beetle *Dendroctonus simplex* (Coleoptera: Scolytidae) in North America. Gt. Lakes Entomol. 22(3):139-154.

Langor, D.W.; Raske, A.G. 1989. The eastern larch beetle, another threat to our forests (Coleoptera: Scolytidae). For. Chron. 65:276-279.

Mallett, K.I. 1989. Pests of trees and shrubs: a different perspective. The Prairie Arborist, Int'l. Soc. of Arboriculture, Prairie Chapter Meeting, September, 1989, Regina, Sask.

Mallett, K.I. 1989. Morphological and cultural characteristics of *Armillaria* root rot pathogens in the prairie provinces of Canada. Pages 392-396 *in* D.J. Morrison, ed., Proc. Seventh Int. Conf. Root Butt Rots, Vernon and Victoria, B.C., August 9-16, 1988. For. Can.-Pacific and Yukon, Victoria, B.C.

Mallett, K.I. 1989. Non-chemical control measures for tree and shrub insect and disease pests. Prairie Landscape Magazine. 12(4):4.

Mallett, K.I.; Hopkin, A.A.; Blenis, P.V. 1989. Vegetative incompatibility in diploid isolates of *Armillaria* North American biological species I and V. Can. J. Bot. 67:3083-3089.

Mugala, M.S.; Blenis, P.V.; Hiratsuka, Y.; Mallett, K.I. 1989. Infection of lodgepole pine and white spruce by Alberta isolates or *Armillaria*. Can. J. For. Res. 19:685-689.

Singh, P.; Sidhu, S.S. 1989. *Armillaria* root rot in fluoride-damaged conifer forest stands in Newfoundland. Pages 521-530 *in* D.J. Morrison, ed., Proc. Seventh Int. Conf. Root Butt Rots, Vernon and Victoria, B.C., August 9-16, 1988. For. Can.-Pacific and Yukon, Victoria, B.C.

Volney, W.J.A. 1989. Biology and dynamics of North American coniferophagus *Choristoneura* populations. Agric. Zool. Rev. 3:133-156.

Unpublished reports

Amirault, P.A. 1989. Forest insect and disease survey pest depletion exercise 1982-87. Page 5 *in* Forest insect and disease notes A-009. For. Can.-Northwest Region, Edmonton, Alberta.

Amirault, P.A.; Pope, B. 1989. Pest distribution and impact in young lodgepole pine stands in west-central Alberta. For. Can.-Northwest Region, Edmonton, Alberta. Prepared under the Canada-Alberta Forest Resource Development Agreement. Rep. Proj. 1410-65.

Cerezke, H. 1989. Sawyer beetles in softwood lumber. Pages 3-4 *in* Forest insect and disease notes, A-012. For. Can.-Northwest Region, Edmonton, Alberta.

Finney-Crawley, J.R. 1989. Investigations to determine the insect vectors of pinewood nematode in Canada. Prepared for For. Can.-Newfoundland and Labrador Region, St. John's, Newfoundland.

Langor, D.W. 1989. The western ash bark beetle. Pages 3-4 *in* Forest insect and disease notes, A-009. For. Can.-Northwest Region, Edmonton, Alberta.

Mallett, K. 1989. Hypoxylon canker. Page 2 *in* Forest insect and disease notes A-009. For. Can.-Northwest Region, Edmonton, Alberta.

Mallett, K. 1989. Comandra blister rusts of hard pines. Page 2 *in* Forest insect and disease notes A-012. For. Can.-Northwest Region, Edmonton, Alberta.

Mallett, K. 1989. Pine needle casts. Page 2 *in* Forest insect and disease notes, A-013. For. Can.-Northwest Region, Edmonton, Alberta.

Volney, J. 1989. The aspen leaf beetle. Pages 3-4 *in* Forest insect and disease notes, A-013. For. Can.-Northwest Region, Edmonton, Alberta.

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Alfaro, R.I. 1989. Probability of damage to Sitka spruce by the Sitka spruce weevil, *Pissodes strobi*. J. Entomol. Soc. B.C. 86:48-54.

Alfaro, R.I.; MacDonald, R.N. 1988. Effects of defoliation by the western false hemlock looper on Douglas-fir tree ring chronologies. Tree Ring Bulletin, 48:3-11.

Anderson, R.L.; Sutherland, J.R. 1989. Soil-pest relationships. Pages 16-17 *in* C.E. Cordell, et al. (Tech. Coordinators). Forest nursery pests. USDA Forest Serv., Agric. Handbook No. 680.

Bloomberg, W.J.; Morrison, D.J. 1989. Relationship of growth reduction in Douglas-fir to infection by *Armillaria* root disease in southeastern British Columbia. Phytopath. 79:482-487.

Callan, B.E.; Rogers, J.D. 1989. *Camarops spathulata*: the teleomorph in agar culture. Sydowia 41:74-78.

Duncan, R.; Lindquist, E.E. 1989. An unusually copious production of webbing by a willow-inhabiting spider mite. *Schizotetranychus schizopus* (Zachor). Can. Ent. 121(12):1037-1039.

Erickson, R.D.; Ferris, R.L. 1989. Forest insect and disease conditions, Cariboo Forest Region 1988. FIDS Rep. 89-1.

Fitz-Earle, M.; Barclay, H.J. 1989. Is there an optimal sex ratio for insect mass rearing? Ecol. Modelling 45:205-220.

Funk, A. 1989. *Pollaccia borealis* sp. nov. associated with a purple-brown leaf spot of aspen. Can. J. Bot. 67:776-778.

Futai, K.; Sutherland, J.R. 1989. Pathogenicity and attractiveness to host extracts of Canadian pinewood nematodes: studies with Scots pine, western larch and black spruce. Can. J. For. Research 19:1256-1261.

Garbutt, R.; Stewart, A. 1989. Forest insect and disease conditions, Prince Rupert Forest Region 1988. FIDS Rep. 89-5.

Grant, G.G.; Fogal, W.H.; West, R.J.; Slessor, K.N.; Miller, G.E. 1989. A sex attractant for the spruce seedmoth *Cydia strobilella* (L.) and the effect of lure dosage and trap height on capture of male moths. Can. Ent. 121:691-697.

Gray, T.G.; Slessor, K.N. 1989. Morphology, life history and identification of sex pheromone components of an undescribed species of *Choristoneura* (Lepidoptera: Tortricidae) on Scots pine in British Columbia. J. Entomol. Soc. B.C. 86:39-47.

Humphreys, N.; Clarke, D.H.L. 1989. Forest insect and disease conditions, Vancouver Forest Region 1988. FIDS Rep. 89-6.

Keates, S.E.; Sturrock, R.N.; Sutherland, J.R. 1989. Populations of adult fungus gnats and shore flies in British Columbia container nurseries as related to nursery environment, and incidence of fungi on the insects. New Forests 3:1-9.

Koot, H.P.; Loranger, J. 1989. Forest insect and disease conditions, Kamloops Forest Region 1988. FIDS Rep. 89-2.

Kozar, F.; Humble, L.M.; Foottit, R.G.; Otvos, I.S. 1989. New and little known scale insects (Homoptera: Coccoidea) from British Columbia. J. Entomol. Soc. B.C. 86:70-77.

McMullen, L.H.; Safranyik, L.; Linton, D.A.; Betts, R. 1988. Survival of self-marked mountain pine beetles emerged from logs dusted with fluorescent powder. J. Entomol. Soc. B.C. 85:25-28.

Miller, G.E. 1988. Compiler, Proc. 3rd Cone and Seed Insects Working Party Conference, IUFRO, Victoria, B.C. June, 1988.

Morrison, D.J.; Thomson, A.J.; Chu, D.; Peet, F.G.; Sahota, T.S. 1989. Variation in isozyme patterns of esterase and polyphenol oxidase among isolates of *Armillaria ostoyae* from British Columbia. Can. J. Plant. Path. 11(3):229-234.

O'Reilly, C.; Owens, J.N.; Arnott, J.T. 1989. Bud development in container-grown western hemlock seedlings subjected to different dormancy induction treatments. Forestry (Oxf.) Suppl. V62:169-179.

Otvos, I.S.; Cunningham, J.C.; Kaupp, W.J. 1989. Aerial application of two baculoviruses against the western spruce budworm, *Choristoneura occidentalis* Freeman (Lepidoptera: Tortricidae) in British Columbia. Can. Ent. 121:209-217.

Panesar, T.S.; Sutherland, J.R. 1989. Pathogenicity of Canadian isolates of the *Bursaphelenchus xylophilus* (pinewood nematode) to provenances of *Pinus sylvestris* and *Pinus contorta* as grown in Finland: A greenhouse study. Scand. J. For. Res. 4:545-557.

Safranyik, L. 1989. The population biology of the spruce beetle in western Canada and implications for management. *In* Payne, T.L.; Saarenmaa, H., eds. Integrated control of scolytid bark beetles. Proc. IUFRO Working Party and XVIII International Congress of Entomology, Vancouver, B.C., July 4, 1988. Virginia Polytechnic Institute, Blacksburg.

Safranyik, L. 1989. Mountain pine beetle overview. *In* G.D. Amman (ed). Can./USA Symp. on mountain pine beetle, Kalispell, MT, and Ogden, UT. July 1988. USDA Forest. Serv. Gen. Tech. Rep. INT-262.

Safranyik, L.; Silversides, R.; McMullen, L.; Linton, D.A. 1989. Local dispersal of the mountain pine beetle and distribution of attacks in a lodgepole pine stand in relation to wind direction and speed. Zeit. Angewandte Ent. 108:498-511.

Sahota, T.S.; Peet, F.G. 1988. Computer-assisted measurement and analysis of chromatin distribution for determining quality differences among bark beetle (Scolytidae) populations. Mem. Entomol. Soc. Can. 146:171-180.

Sahota, T.S.; Peet, F.G. 1988. Changes in the quality of scolytid populations: their determination and relation to scolytid outbreaks. *In* Payne, T.L.; Saarenmaa, H., eds. Integrated control of scolytid bark beetles. Proc. IUFRO Working Party and XVIII International Congress of Entomology, Vancouver, B.C., July 4, 1988. Virginia Polytechnic Institute, Blacksburg.

Shepherd, R.F.; Bennett, D.D.; Dale, J.W.; Tunnock, S.; Dolph, R.D.; Thier, R.W. 1988. Evidence of synchronized cycles in outbreak patterns of Douglas-fir tussock moth, *Orgyia pseudotsugata* (McDunnough) (Lepidoptera: Lymantriidae). Mem. Entomol. Soc. Can. 146:107-121.

Shepherd, R.F.; Van Sickle, G.A.; Clarke, D.H.L. 1989. Spatial relationships of Douglas-fir tussock moth defoliation within habitat and climatic zones. *In* Proc. Seminar, A comparison of features of new and old world tussock moths: Lymantriidae. USDA Forest Serv. Gen. Tech. Rept. NE-123:381-400.

Shore, T.L. 1989. Sampling western hemlock looper pupae (Lepidoptera: Geometridae) using burlap traps. J. Entomol. Sci. 24(3):348-364.

Turnquist, R. 1989. Forest insect and disease conditions, Yukon Territory, 1988. FIDS Rep. 89-7.

Turnquist, R.; Ferris, R. 1989. Forest insect and disease conditions, Prince George Forest Region 1988. FIDS Rep. 89-4.

Unger, L.; Vallentgoed, J. 1989. Forest insect and disease conditions, Nelson Forest Region 1988. FIDS Rep. 89-3.

Van Sickle, G.A. 1989. GIS - A tool in forest pest management. Pages 213-219 *in* GIS '89, A wider perspective. International symposium on geographic information systems. Vancouver, B.C. Forestry Canada/Reid, Collins and Associates.

Van Sickle, G.A. 1989. Status of mountain pine beetle in Western Canada, 1988. Canada/USA mountain pine beetle symposium, Kalispell, MT. July 12-14, 1988. USDA For. Serv. Gen. Tech. Rep. INT-262:6-8.

Van Sickle, G.A.; Miller, G. 1988. Pests - what they look like, what they do. Pages 29-35 *in* Proc. Regeneration to rotation, keeping the lid on pest losses. A

symposium for managers. BC Forest Serv. Symp. Richmond, B.C. Nov. 16-17, 1988.

Wood, C.S.; Van Sickle, G.A. 1989. Forest insect and disease conditions, British Columbia and Yukon 1988. For. Can.-Pacific and Yukon Region, Inf. Rep. BC-X-306.

Wood, C.S.; Van Sickle, G.A. 1989. Forest insect and disease conditions in the Pacific Region: a mid-season summary. Special Report, For. Can.-Pacific and Yukon Region.

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D'Eon, S.P.; Power, J.M. 1989. The plot network of the Acid Rain National Early Warning System. For. Can. Inf. Rep. PI-X-91.

Fogal, W.H.; Lopushanski, S.M. 1989. Stem incorporation of systemic insecticides to protect white spruce seed trees. For. Chron. 65:359-364.

Leckie, D.G.; Ostaff, D.P.; Teillet, P.M.; Fedosjevs, G. 1989. Spectral characteristics of tree components of balsam fir and spruce damaged by spruce budworm. Forest. Sci. 35:582-600.